BULLETIN OF THE IMPERIAL INSTITUTE

A QUARTERLY RECORD OF PROGRESS IN TROPICAL AGRICULTURE AND INDUSTRIES AND THE COMMERCIAL UTILISATION OF THE NATURAL RESOURCES OF THE COLONIES AND INDIA

EDITED BY THE DIRECTOR AND PREPARED BY THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE AND BY OTHER CONTRIBUTORS

VOL. XII NO. 4

LONDON
JOHN MURRAY, ALBEMARLE STREET, W.
1914

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

The following summaries have been prepared from a selection of the Reports made by the Director of the Imperial Institute to the Colonial, Indian, and other Governments concerned.

SOILS FROM THE EAST AFRICA PROTECTORATE

At the Third International Congress of Tropical Agriculture, held at the Imperial Institute in June last, Mr. Harcourt, Secretary of State for the Colonies, drew attention to the possibility of utilising the land bordering on the Juba River in East Africa, for the cultivation of cotton and other tropical products. This could be done by erecting barrages and constructing irrigation works. The matter also formed the subject of a paper by Dr. N. M. Alemanni, read before the same Congress. Experiments in cotton growing in this region have been undertaken already on behalf of the Department of Agriculture of the Protectorate, and certain areas have been irrigated by canals. The results of the experiments have been quite successful, and a yield of 1,800 lb. of seed-cotton per acre was obtained at Halwalood in 1911–12. A knowledge of the character of the soil in this region is of considerable importance in this connection, and a number of samples obtained from the British side of the river have been examined at the Imperial Institute in recent years. Analyses of some of these have already been published in this Bulletin (1912, **10**, 416), and in the following pages an account is given of the results of examination of twenty-four soils collected at Gosha, Jubaland.

Each sample was submitted to (1) a mechanical analysis

and (2) a chemical analysis. In two cases (Nos. 1 and 2) the mechanical analysis was performed on the entire soil, which was air-dried before examination, but the remaining samples contained varying amounts of calcium carbonate (in the form of lumps, fine particles, or small shells) which was removed by treatment with dilute acid before the mechanical analysis was performed; the results in these, as in all other cases, are expressed on the entire soil. The chemical analysis was performed on the portion of soil passing a 1 mm. sieve; the figures giving the "available" constituents in pounds per acre were calculated in each case for a depth of 9 in., the apparent specific gravity of the soil being taken into consideration.

No. 1.—"Collected on Halwalood Plain about 400 yards from the Juba River, and about 100 yards north of the main irrigation canal." This was a sample of clay soil.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3·80	3·80	8·55	71·93	11·82	0·10[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (Cl), *sulphates equal to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·04 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	1·74	—	—
Magnesia	MgO	—	2·35	—	—
Potash	K_2O	—	1·05	0·01	268
Ferric oxide	Fe_2O_3	—	8·84	—	—
Phosphoric acid	P_2O_5	—	0·15	0·03	804
Nitrogen	N	0·06[1]	—	—	—
Carbon dioxide	CO_2	0·55	—	—	—
Loss on ignition		19·91	—	—	—
Humus		0·51[2]	—	—	—

[1] *Equivalent to* 1,609 *lb. per acre.* [2] *Containing nitrogen* 3·1 *per cent.*

This soil contains adequate supplies of mineral plant

food constituents. The percentage of nitrogen present is low, and the soil would benefit by "green manuring." Owing to the quantity of sodium carbonate present, the soil would not be suitable for the cultivation of crops which are specially sensitive to this constituent.

No. 2.—"Collected at the base of salt bushes, about 100 yards west of spot from which preceding sample (No. 1) was taken." This was also a sample of clay soil.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
2·45	3·23	9·65	74·95	9·47	0·25[1]

[1] *Including chlorides equivalent to* 0·05 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·11 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	2·36	—	—
Magnesia	MgO	—	2·51	—	—
Potash	K_2O	—	0·97	0·02	553
Ferric oxide	Fe_2O_3	—	8·96	—	—
Phosphoric acid	P_2O_5	—	0·17	0·05	1,381
Nitrogen	N	0·06[1]	—	—	—
Carbon dioxide	CO_2	1·13	—	—	—
Loss on ignition		19·64	—	—	—
Humus		0·80[2]	—	—	—

[1] *Equivalent to* 1,658 *lb. per acre.* [2] *Containing nitrogen* 2·5 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is low. The soil contains too much alkali, and is of a type upon which none but alkali-resistant crops will grow.

No. 3.—"Collected on Halwalood Plain, about 300 yards west of the clump of salt bushes referred to under sample No. 2." This also was a clay soil. It contained 1·32 per cent. of calcium carbonate ($CaCO_3$), in the form of lumps and finely disseminated particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3·50	4·34	11·39	66·93	12·28	0·24 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·05 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·05 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	2·26	—	—
Magnesia	MgO	—	3·02	—	—
Potash	K_2O	—	1·07	0·012	293
Ferric oxide	Fe_2O_3	—	5·77	—	—
Phosphoric acid	P_2O_5	—	0·11	0·021	512
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	0·58	—	—	—
Loss on ignition		20·22	—	—	—
Humus		0·87 [2]	—	—	—

[1] *Equivalent to* 1,707 *lb. per acre.* [2] *Containing nitrogen* 3·45 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low. The soil would probably benefit by "green manuring." It appears to contain too much alkali salt to be used for the cultivation of many of the common crops.

No. 4.—"Collected on Halwalood Plain from a plot which had been under cotton." This soil was a highly calcareous clay. It contained 12·41 per cent. of calcium carbonate ($CaCO_3$) in the form of finely disseminated particles, lumps, and small shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	4·20	22·30	51·63	9·27	0·19 [1]

[1] *Including chlorides equivalent to* 0·006 *per cent. chlorine* (*Cl*), *sulphates equivalent to* 0·05 *per cent. sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·02 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	7·65	—	—
Magnesia	MgO	—	2·66	—	—
Potash	K_2O	—	0·88	0·021	554
Ferric oxide	Fe_2O_3	—	4·98	—	—
Phosphoric acid	P_2O_5	—	0·11	0·033	871
Nitrogen	N	0·08[1]	—	—	—
Carbon dioxide	CO_2	5·46	—	—	—
Loss on ignition		21·68	—	—	—
Humus		0·68[2]	—	—	—

[1] *Equivalent to* 2,113 *lb. per acre.* [2] *Containing nitrogen* 7·35 *per cent.*

This soil contains adequate supplies of mineral plant food constituents, particularly calcium carbonate. The percentage of nitrogen present is somewhat low and the land would probably benefit by a course of "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 5.—"Taken from cultivated land about 200 yards from the Juba River, behind the engineer's quarters. This land was for two years under irrigation, and a fairly thick deposit of river silt had settled on the surface." A sample of fine-textured loam. The soil contained 4·02 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	5·61	44·81	35·16	10·17	0·23[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·03 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·06 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	4·41	—	—
Magnesia	MgO	—	2·59	—	—
Potash	K_2O	—	1·16	0·02	524
Ferric oxide	Fe_2O_3	—	7·88	—	—
Phosphoric acid	P_2O_5	—	0·16	0·05	1,311
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	1·77	—	—	—
Loss on ignition		20·72	—	—	—
Humus		0·63 [2]	—	—	—

[1] *Equivalent to* 1,835 *lb. per acre.* [2] *Containing nitrogen* 3·43 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low, and the land would probably benefit by a course of "green manuring." The soil contains too large a percentage of sodium carbonate to be used for the cultivation of crops sensitive to alkali.

No. 6.—"River silt." A sample of loamy clay soil. It contained 9·88 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	10·32	12·60	57·69	9·31	0·20 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·05 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·03 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	5·22	—	—
Magnesia	MgO	—	2·43	—	—
Potash	K_2O	—	0·94	0·02	520
Ferric oxide	Fe_2O_3	—	7·36	—	—
Phosphoric acid	P_2O_5	—	0·16	0·05	1,300
Nitrogen	N	0·06 [1]	—	—	—
Carbon dioxide	CO_2	4·35	—	—	—
Loss on ignition		20·95	—	—	—
Humus		0·72 [2]	—	—	—

[1] *Equivalent to* 1,559 *lb. per acre.* [2] *Containing nitrogen* 2·56 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low and the land would probably benefit by "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 7.—"Taken from cultivated land about 100 yards north-east of the Swedish Mission, Yonti, on a part of the land proposed to be used as a Government Experimental Farm." A sample of highly calcareous clay soil. It contained 16·09 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	4·42	19·26	50·14	9·16	0·93 [1]

[1] *Including chlorides equivalent to* 0·20 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·28 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·015 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO . .	—	10·52	—	—
Magnesia	MgO . .	—	2·01	—	—
Potash	K_2O . .	—	1·40	0·10	2,367
Ferric oxide	Fe_2O_3 . .	—	6·52	—	—
Phosphoric acid	P_2O_5 . .	—	0·33	0·17	4,025
Nitrogen	N . . .	0·19 [1]	—	—	—
Carbon dioxide	CO_2 . .	7·08	—	—	—
Loss on ignition	. . .	22·96	—	—	—
Humus .	. . . .	1·46 [2]	—	—	—

[1] *Equivalent to* 4,499 *lb. per acre.* [2] *Containing nitrogen* 4·04 *per cent.*

This soil contains a sufficiency of plant food constituents, being particularly well supplied with calcium carbonate, "available" potash, and phosphoric acid. The nature of the soluble matter present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 8.—"Collected on low-lying land, sometimes flooded by fresh water, on plot No. 2, about 100 yards from the Juba River. The plants growing here include a Commelina and various members of Malvaceæ and Compositæ." A sample of fine-textured and calcareous loam. The soil contained 13·22 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	8·59	40·65	30·79	6·55	0·20[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·03 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·055 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	8·45	—	—
Magnesia	MgO	—	2·07	—	—
Potash	K_2O	—	1·19	0·08	1,970
Ferric oxide	Fe_2O_3	—	5·60	—	—
Phosphoric acid	P_2O_5	—	0·23	0·10	2,463
Nitrogen	N	0·17[1]	—	—	—
Carbon dioxide	CO_2	5·82	—	—	—
Loss on ignition		19·00	—	—	—
Humus		1·68[2]	—	—	—

[1] *Equivalent to* 4,188 *lb. per acre.* [2] *Containing nitrogen* 3·59 *per cent.*

This soil contains a sufficiency of plant food constituents, being particularly well supplied with calcium carbonate, "available" potash, and phosphoric acid. The soil contains too large a percentage of sodium carbonate to be useful for the successful cultivation of plants sensitive to alkali.

No. 9.—"Collected about half a dozen yards from bank of Juba River, in centre of patch of an *Astragalus* sp., or vetch-like plant, on site of proposed Experimental Farm,

Yonti." A sample of light brown and calcareous sandy soil. It contained 8·25 per cent. of calcium carbonate ($CaCO_3$) in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	53·71	26·25	9·58	2·08	0·13[1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·015 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	4·69	—	—
Magnesia	MgO	—	0·65	—	—
Potash	K_2O	—	0·37	0·02	561
Ferric oxide	Fe_2O_3	—	2·68	—	—
Phosphoric acid	P_2O_5	—	0·13	0·02	561
Nitrogen	N	0·05[1]	—	—	—
Carbon dioxide	CO_2	3·33	—	—	—
Loss on ignition		7·38	—	—	—
Humus		0·36[2]	—	—	—

[1] *Equivalent to* 1,403 *lb. per acre.* [2] *Containing nitrogen* 6·77 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is low, and the soil would probably benefit by "green manuring." The nature of the soluble matter present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 10.—"Collected about 150 yards from Juba River and about 100 yards south of native place of worship on proposed Experimental Farm, Yonti. Small trees of 'John Bull,' *Thespesia* sp., are growing on the land; also grass from 1½ to 2 ft. high, much liked by cattle." A sample of dark brown calcareous loam. The soil contained 11·05 per cent. of calcium carbonate ($CaCO_3$), in the form of broken shells and small nodules.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	22·99	28·71	30·27	6·77	0·21[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·019 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	7·49	—	—
Magnesia	MgO	—	1·52	—	—
Potash	K_2O	—	0·89	0·06	1,432
Ferric oxide	Fe_2O_3	—	4·60	—	—
Phosphoric acid	P_2O_5	—	0·28	0·10	2,386
Nitrogen	N	0·14[1]	—	—	—
Carbon dioxide	CO_2	4·86	—	—	—
Loss on ignition		16·51	—	—	—
Humus		1·24[2]	—	—	—

[1] *Equivalent to* 3,340 *lb. per acre.* [2] *Containing nitrogen* 3·36 *per cent.*

This soil contains a sufficiency of plant food constituents, being particularly well supplied with calcium carbonate, "available" potash, and phosphoric acid. The nature of the soluble salts present may render this soil unsuitable for the cultivation of crops sensitive to alkali.

No. 11.—"Collected from about the centre of a small plain about 100 yards west of native cemetery adjoining the site of the suggested Experimental Farm. The only vegetation is a creeping grass resembling Cynodon. During heavy rains this land is under water. The area of the small plain referred to above is about 650 yards by 300 yards, and would be included in the Experimental Farm section." A sample of calcareous, clayey soil which contained 9·82 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·00	26·00	52·92	10·16	0·10[1]

[1] *Including chlorides equivalent to* 0·03 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·01 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·02 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	5·77	—	—
Magnesia	MgO	—	1·87	—	—
Potash	K_2O	—	0·77	0·03	762
Ferric oxide	Fe_2O_3	—	7·84	—	—
Phosphoric acid	P_2O_5	—	0·15	0·02	508
Nitrogen	N	0·06[1]	—	—	—
Carbon dioxide	CO_2	4·32	—	—	—
Loss on ignition		21·29	—	—	—
Humus		0·62[2]	—	—	—

[1] *Equivalent to* 1,600 *lb. per acre.* [2] *Containing nitrogen* 5·8 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is low and the soil would probably benefit by "green manuring." The nature of the soluble salts present renders the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 12.—"Collected on the small plain about 150 yards from the Swedish Mission on Experimental Farm area, Yonti." A sample of fine-textured and calcareous clay loam. It contained 11·16 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105°C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	2·80	33·55	44·57	7·86	0·06[1]

[1] *Including chlorides equivalent to* 0·003 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·015 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·014 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	8·09	—	—
Magnesia	MgO	—	1·56	—	—
Potash	K_2O	—	0·81	0·01	246
Ferric oxide	Fe_2O_3	—	6·24	—	—
Phosphoric acid	P_2O_5	—	0·14	0·02	492
Nitrogen	N	0·09[1]	—	—	—
Carbon dioxide	CO_2	4·91	—	—	—
Loss on ignition		19·94	—	—	—
Humus		0·70[2]	—	—	—

[1] *Equivalent to* 2,164 *lb. per acre.* [2] *Containing nitrogen* 4·7 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is slightly low. The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 13.—"Collected from farm No. 1 from gently sloping land just out of flood area, about 120 yards east of dwelling-house and 100 yards from Juba River. The vegetation is small Acacia scrub and dwarf grass." A sample of sandy loam, which contained 3·41 per cent. of calcium carbonate ($CaCO_3$) in the form of fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·48	45·20	15·55	29·82	5·50	0·04[1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·018 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equal to* 0·003 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	1·90	—	—
Magnesia	MgO	—	0·19	—	—
Potash	K_2O	—	0·48	0·01	264
Ferric oxide	Fe_2O_3	—	3·52	—	—
Phosphoric acid	P_2O_5	—	0·02	0·007	185
Nitrogen	N	0·053[1]	—	—	—
Carbon dioxide	CO_2	1·50	—	—	—
Loss on ignition		9·77	—	—	—
Humus		0·32[2]	—	—	—

[1] *Equivalent to* 1,400 *lb. per acre.* [2] *Containing nitrogen* 5·6 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, except that the reserve of phosphoric acid, as shown by the quantity soluble in hydrochloric acid, is low. The percentage of nitrogen is also low and "green manuring" would probably prove beneficial. The quantity of alkali salts present is not likely to prove injurious to plant growth, except perhaps in the case of those very sensitive to alkali.

No. 14.—"Farm No. 1. Taken from west side of a millet shamba about 100 yards north of spot from which sample No. 1 was collected." A sample of clay soil. It contained 7·23 per cent. of calcium carbonate ($CaCO_3$) in the form of fine particles and shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105°C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·01	3·75	11·90	66·98	10·06	0·07[1]

[1] *Including chlorides equivalent to* 0·004 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·022 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·016 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	4·38	—	—
Magnesia	MgO	—	1·42	—	—
Potash	K_2O	—	0·72	0·019	448
Ferric oxide	Fe_2O_3	—	7·36	—	—
Phosphoric acid	P_2O_5	—	0·14	0·035	825
Nitrogen	N	0·08 [1]	—	—	—
Carbon dioxide	CO_2	3·18	—	—	—
Loss on ignition		19·61	—	—	—
Humus		0·52 [2]	—	—	—

[1] *Equivalent to* 2,004 *lb. per acre.* [2] *Containing nitrogen* 5·8 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the amount of nitrogen present is low, and the soil would probably benefit by "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 15.—"Farm No. 1. Collected from about the centre of flood area, on plain about one-third the distance between the dwelling-houses of farm No. 1 and Bulmerara. Vegetation—small Acacia shrubs and low grass of a sparse nature." A sample of calcareous clayey soil. It contained 8·16 per cent. of calcium carbonate ($CaCO_3$), in the form of pieces of shell and finely divided particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·33	12·20	67·16	10·94	0·21 [1]

[1] *Including chlorides equivalent to* 0·02 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·042 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	6·45	—	—
Magnesia	MgO	—	2·32	—	—
Potash	K_2O	—	1·29	0·01	247
Ferric oxide	Fe_2O_3	—	8·20	—	—
Phosphoric acid	P_2O_5	—	0·14	0·03	743
Nitrogen	N	0·09[1]	—	—	—
Carbon dioxide	CO_2	3·60	—	—	—
Loss on ignition		23·49	—	—	—
Humus		0·73[2]	—	—	—

[1] *Equivalent to* 2,229 *lb. per acre.* [2] *Containing nitrogen* 4·60 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen is slightly low. The amount of alkali present is probably too large to permit of the successful cultivation of certain crops sensitive to alkali.

No. 16.—"Collected from about the centre of plain, and midway between the dwelling-houses of farm No. 1 and Bulmerara. During flood time the area is under water. Commelina, sparse low grass, and tiny shrubs compose the vegetation." A sample of fine-textured and calcareous clay loam. The soil contained 9·32 per cent. of calcium carbonate ($CaCO_3$), in the form of broken shells and small nodules under $\frac{1}{4}$ in. diameter.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	3·42	50·36	26·23	10·55	0·12[1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·018 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	6·63	—	—
Magnesia	MgO	—	2·13	—	—
Potash	K_2O	—	1·03	0·02	482
Ferric oxide	Fe_2O_3	—	8·32	—	—
Phosphoric acid	P_2O_5	—	0·21	0·06	1,447
Nitrogen	N	0·07 [1]	—	—	—
Carbon dioxide	CO_2	4·10	—	—	—
Loss on ignition		23·23	—	—	—
Humus		0·58 [2]	—	—	—

[1] *Equivalent to* 1,688 *lb. per acre.* [2] *Containing nitrogen* 3·73 *per cent.*

This soil contains a sufficiency of mineral plant food constituents, but the percentage of nitrogen present is low, and the soil would probably benefit by "green manuring." The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 17.—"Taken two yards from boundary of farm No. 1 and Bulmerara (on farm No. 1 side) and adjoining [land] recently cultivated and ridged on the Bulmerara Estate. The position is on a straight line between the dwelling-houses of the farm named above." A sample of calcareous clayey soil. It contained 12·66 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps, fine particles, and shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	2·75	5·50	67·46	11·56	0·07 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·026 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·007 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	8·03	—	—
Magnesia	MgO	—	1·35	—	—
Potash	K_2O	—	0·99	0·014	353
Ferric oxide	Fe_2O_3	—	7·92	—	—
Phosphoric acid	P_2O_5	—	0·25	0·049	1,235
Nitrogen	N	0·071 [1]	—	—	—
Carbon dioxide	CO_2	5·57	—	—	—
Loss on ignition		23·48	—	—	—
Humus		0·53 [2]	—	—	—

[1] *Equivalent to* 1,789 *lb. per acre.* [2] *Containing nitrogen* 4·7 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the amount of nitrogen is low, and the soil would probably benefit by "green manuring." The soluble salts present are not likely to prove harmful to plant growth, except perhaps in the case of plants very sensitive to alkali.

No. 18.—"Collected on Bulmerara Estate in the centre of a small field, which at the time of collection was lying fallow, but in 1911 gave a return of 1,400 lb. of seed-cotton per acre. Formerly the land had a dense growth of Doum palms." A sample of highly calcareous clayey soil. It contained 14·36 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·50	16·35	58·25	9·41	0·13 [1]

[1] *Including chlorides equivalent to* 0·01 *per cent. of chlorine* (*Cl*), *sulphates equivalent to* 0·056 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·008 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO . .	—	8·46	—	—
Magnesia	MgO . .	—	2·36	—	—
Potash	K_2O . .	—	1·07	0·032	858
Ferric oxide	Fe_2O_3 . .	—	6·96	—	—
Phosphoric acid	P_2O_5 . .	—	0·29	0·109	2,924
Nitrogen	N . . .	0·127 [1]	—	—	—
Carbon dioxide	CO_2 . .	6·32	—	—	—
Loss on ignition	. . .	21·78	—	—	—
Humus		0·95 [2]	—	—	—

[1] *Equivalent to* 3,406 *lb. per acre.* [2] *Containing nitrogen* 4·8 *per cent.*

This soil contains a good supply of plant food constituents, particularly "available" phosphoric acid and calcium carbonate. The quantity of soluble salts present is not likely to prove injurious to plant growth, except perhaps in the case of plants very sensitive to alkali.

No. 19.—"Collected on Mr. Powys Cobb's farm at a spot about 150 yards from the Juba River in a straight line with the dwelling-house. The land is under water during flood-time. Vegetation—good grass." A sample of calcareous clayey soil, which contained 13·41 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps and fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·55	13·55	61·04	11·35	0·10 [1]

[1] *Including chlorides equivalent to* 0·005 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·002 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·055 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	9·15	—	—
Magnesia	MgO	—	1·72	—	—
Potash	K_2O	—	0·92	0·017	435
Ferric oxide	Fe_2O_3	—	5·86	—	—
Phosphoric acid	P_2O_5	—	0·19	0·035	896
Nitrogen	N	0·093[1]	—	—	—
Carbon dioxide	CO_2	5·90	—	—	—
Loss on ignition		23·09	—	—	—
Humus		0·82[2]	—	—	—

[1] *Equivalent to* 2,381 *lb. per acre.* [2] *Containing nitrogen* 3·5 *per cent.*

The soil contains a sufficiency of mineral plant food constituents, but the amount of sodium carbonate present will prohibit its use for the cultivation of certain crops sensitive to alkali.

No. 20.—"Collected on Mr. Powys Cobb's farm about 450 yards from Juba River in a line with the dwelling-house. The land is under water during high flood. Vegetation—rank grass of a tiny bamboo-like nature." A sample of calcareous clay soil. It contained 16·50 per cent. of calcium carbonate ($CaCO_3$) in the form of lumps, fine particles, and shells.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
0·12	1·45	11·20	59·03	11·66	0·04[1]

[1] *Including chlorides equivalent to* 0·005 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·001 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·007 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	9·72	—	—
Magnesia	MgO	—	1·44	—	—
Potash	K_2O	—	0·94	0·025	559
Ferric oxide	Fe_2O_3	—	8·08	—	—
Phosphoric acid	P_2O_5	—	0·41	0·050	1,118
Nitrogen	N	0·143[1]	—	—	—
Carbon dioxide	CO_2	7·26	—	—	—
Loss on ignition		25·27	—	—	—
Humus		1·40[2]	—	—	—

[1] *Equivalent to* 3,196 *lb. per acre.* [2] *Containing nitrogen* 2·6 *per cent.*

The soil contains a sufficiency of plant food constituents. The amount of soluble salts present is not likely to prove harmful to plant growth, except perhaps in the case of plants which are very sensitive to alkali.

No. 21.—"Taken from a spot just outside flood area, about 750 yards from the Juba River in a straight line with the dwelling-house. Grass short and good. The Doum palms commence about 450 yards behind this spot or 1,150 yards from the Juba River." A calcareous, clayey soil, which contained 12·34 per cent. of calcium carbonate ($CaCO_3$) in the form of small nodules and finely divided particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·59	7·07	70·06	8·81	0·13[1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·02 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·026 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	9·84	—	—
Magnesia	MgO	—	2·68	—	—
Potash	K_2O	—	0·47	0·04	953
Ferric oxide	Fe_2O_3	—	7·52	—	—
Phosphoric acid	P_2O_5	—	0·36	0·09	2,145
Nitrogen	N	0·10 [1]	—	—	—
Carbon dioxide	CO_2	5·43	—	—	—
Loss on ignition		23·33	—	—	—
Humus		1·22 [2]	—	—	—

[1] *Equivalent to* 2,383 *lb. per acre.* [2] *Containing nitrogen* 3·94 *per cent.*

This soil contains a sufficiency of plant food constituents. The nature of the soluble salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 22.—"Collected on fallow land on Count Franckenstein's farm (No. 7) about 200 yards from the Juba River in a straight line with the dwelling-house." A sample of calcareous, clayey soil. It contained 18·91 per cent. of calcium carbonate ($CaCO_3$), in the form of fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·45	20·10	52·77	7·70	0·07 [1]

[1] *Including chlorides equivalent to* 0·004 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·018 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·014 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	11·79	—	—
Magnesia	MgO	—	1·79	—	—
Potash	K_2O	—	0·79	0·049	1,264
Ferric oxide	Fe_2O_3	—	8·16	—	—
Phosphoric acid	P_2O_5	—	0·17	0·063	1,626
Nitrogen	N	0·12 [1]	—	—	—
Carbon dioxide	CO_2	8·32	—	—	—
Loss on ignition		22·33	—	—	—
Humus		1·36 [2]	—	—	—

[1] *Equivalent to* 3,097 *lb. per acre.* [2] *Containing nitrogen* 3·1 *per cent.*

The soil contains a sufficiency of plant food constituents. The nature and quantity of the alkali salts present may render the soil unsuitable for the cultivation of crops sensitive to alkali.

No. 23.—"Collected at a spot about 200 yards north-east of dwelling-house on farm No. 7 and close to the boundary of farm No. 6—also the property of Count Franckenstein. Low, good grass." A sample of calcareous, clayey soil. It contained 14·23 per cent. of calcium carbonate ($CaCO_3$) in the form of fine particles.

Mechanical Analysis

Size of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	1·15	5·70	66·79	12·08	0·05[1]

[1] *Including a trace of chlorides, sulphates equivalent to* 0·015 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·008 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	9·32	—	—
Magnesia	MgO	—	1·94	—	—
Potash	K_2O	—	0·62	0·015	378
Ferric oxide	Fe_2O_3	—	8·48	—	—
Phosphoric acid	P_2O_5	—	0·16	0·025	630
Nitrogen	N	0·103[1]	—	—	—
Carbon dioxide	CO_2	6·26	—	—	—
Loss on ignition		25·93	—	—	—
Humus		1·41[2]	—	—	—

[1] *Equivalent to* 2,595 *lb. per acre.* [2] *Containing nitrogen* 3·5 *per cent.*

The soil contains a sufficiency of plant food constituents. The quantity of soluble salts present is not likely to prove harmful to plant growth, except perhaps in the case of those plants which are very sensitive to alkali.

No. 24.—"Taken about 500 yards away from Juba River on farm No. 7, in a straight line with dwelling-house. The land is under water during high flood and contains rank,

reed-like grass." A calcareous clay soil which contained 10·25 per cent. of calcium carbonate ($CaCO_3$), in the form of lumps and fine particles.

Mechanical Analysis

Sizes of particles in millimetres.				Moisture at 105° C.	Matter soluble in water.
Over 1·0 (gravel).	1·0 to 0·1 (sand).	0·1 to 0·01 (silt).	0·01 and under (fine silt and clay).		
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Nil	0·25	0·55	74·26	14·64	0·05[1]

[1] *Including chlorides equivalent to* 0·007 *per cent. of chlorine* (Cl), *sulphates equivalent to* 0·017 *per cent. of sulphuric acid* (SO_3), *and alkaline carbonates equivalent to* 0·008 *per cent. of sodium carbonate* (Na_2CO_3).

Chemical Analysis

		Total.	Soluble in hydrochloric acid.	"Available" constituents, *i.e.* portion soluble in 1 per cent. citric acid solution.	
		Per cent.	*Per cent.*	*Per cent.*	*lb. per acre.*
Lime	CaO	—	7·42	—	—
Magnesia	MgO	—	1·66	—	—
Potash	K_2O	—	0·94	0·028	671
Ferric oxide	Fe_2O_3	—	8·40	—	—
Phosphoric acid	P_2O_5	—	0·21	0·083	1,990
Nitrogen	N	0·146[1]	—	—	—
Carbon dioxide	CO_2	4·51	—	—	—
Loss on ignition		27·08	—	—	—
Humus		1·55[2]	—	—	—

[1] *Equivalent to* 3,501 *lb. per acre.* [2] *Containing nitrogen* 3·8 *per cent.*

This soil contains a sufficiency of plant food constituents. The quantity of soluble salts present is not likely to prove harmful to plant growth, except perhaps in the case of those plants which are very sensitive to alkali.

Remarks

Nearly all the soils under report are of a clayey character and have good moisture-retaining properties. They all contain adequate quantities of calcium carbonate; in many instances, *e.g.* samples Nos. 4, 6, 7 to 12, and 14 to 24, the quantity present substantially exceeds 6 per cent. This constituent is of considerable importance in improving the heavy nature of the clay.

The quantity of the mineral constituents necessary for plant growth is adequate in all cases, but the amount of total phosphoric acid is below standard in soil No. 13.

Certain of the soils are somewhat deficient in nitrogen, and the percentage of this constituent in the humus is in some cases rather low. Both these defects might be remedied by "green manuring."

All the soils were found to contain alkaline carbonates, which have a very harmful effect on plant growth when present in quantity. Sodium chloride and sulphates were also present, but not in quantities likely to prove injurious, except perhaps in the case of soil No. 7. In this respect the soils differ from a sample previously examined from Halwalood (this BULLETIN, 1912, **10**, 418), which contained 1·31 per cent. of sodium sulphate and 0·28 per cent. of sodium chloride.

In the descriptions which accompanied the samples, it is stated that the land represented by samples Nos. 8, 11, 15, 16, 19, 20, and 24, is subject to periodical flooding. This being the case, it would be necessary to exercise care in the reclaiming of such land, as the prevention of this flooding may lead to the accumulation of considerable quantities of alkali salts in the surface soil. If the land is irrigated, without under-drainage being adopted, the isolated patches containing high proportions of alkali may spread to the areas not yet seriously affected, but the danger in the case of clay soils is somewhat less than in the case of those of a sandy character.

As the quantity of sodium chloride present in all the soils is low, except in the case of soil No. 7, it seems possible that the harmful effect of the sodium carbonate can be minimised by applying dressings of calcium sulphate ("land plaster"). According to Loughbridge (*Annual Report of Californian Experiment Station*, 1896–7) the quantity of calcium sulphate applied to a soil for this purpose should be about double the weight of sodium carbonate present in the soil to a depth of 4 ft. An excess of calcium sulphate will do no harm unless the soil is badly waterlogged.

The *minimum* quantity of calcium sulphate required, on Loughbridge's estimate, to neutralise the sodium carbonate

in soils containing varying amounts of the alkali, is shown in the following table. The calculations are based on the requirements of the soil to a depth of 4 ft., and on the assumption that the soil has an apparent specific gravity of 1·3.

Sodium carbonate in soil. *Per cent.*	Calcium sulphate required. *lb. per acre.*
0·001	288
0·005	1,442
0·01	2,884
0·10	28,840

With reference to the possibility of obtaining crops on land containing alkali, without previous treatment, there seems to be little information available. The figures in the following table, compiled from the data given in *Bulletins* 128, 133, and 140 of the *Californian Experiment Station*, may be of service in this connection. They give the maximum tolerance of various crops towards sodium carbonate.

	Sodium carbonate in 4 ft. of soil.	
	lb. per acre.	*Per cent.*[1]
Wheat	1,480	0·013
Barley	12,170	0·112
Rye	960	0·009
Sweet corn	1,800	0·016
Kaffir corn	1,800	0·016
Sunflower	1,760	0·016
Alfalfa	2,360	0·022
Sorghum	9,840	0·091
Hairy vetch	2,480	0·023
Apples	640	0·006
Pears	1,760	0·016
Lemons	480	0·004

[1] *Calculated for a soil having an apparent specific gravity of* 1·3.

In many of the above cases the sodium carbonate was accompanied by small quantities of calcium sulphate, which would have an ameliorating effect.

In considering these figures in relation to the soils under report, it must be remembered that owing to the close proximity of the Juba River to many of the areas from which the samples were taken, it is highly probable that during the year there will be wide variations in the quantity of soluble salts in the surface soil, owing to variations in the level of the water table.

The results of analyses given in the present report are useful as indicating the kind of crop which could probably be grown on the soils. Other factors, however, such as climate, must also be taken into consideration, and before any definite conclusions in this direction can be reached it would be necessary to carry out trial cultivation experiments This is especially the case with soils such as those dealt with above, which contain small amounts of alkali salts.

TEA FROM NEW SOURCES

THE cultivation of tea has been attempted in a number of British possessions outside India and Ceylon, and notably in parts of Africa. The industry in Natal and Nyasaland has already been referred to in this BULLETIN (1908, **6**, 1; 1913, **11**, 302). Experiments in tea growing have been made by the Department of Agriculture in the Southern Provinces, Nigeria, and two samples of the product have been examined at the Imperial Institute; they proved to be of good quality (this BULLETIN, 1912, **10**, 395). Samples of tea have also been received from Uganda, East Africa Protectorate, and Fiji, and these are dealt with in the following pages.

UGANDA

Tea growing in Uganda is at present only in the experimental stage, two plots being grown at the Government Plantation at Kampala. In the lower plot, situated near a drained swamp, the growth has been good, but in the other, at a higher level, the plants are stunted and make little or no progress.

A sample of tea grown and prepared at Kampala was received at the Imperial Institute in November 1913. It consisted of rolled black tea, dry and in good condition, but of somewhat uneven colour, a small quantity of light-coloured leaf being present.

The tea was chemically examined with the following results:

	Expressed on material as received. *Per cent.*	Expressed on material dried at 100° C. *Per cent.*
Moisture	8·05	—
Caffeine	3·67	4·0
Tannin[1]	9·5	10·3
Ash	4·76	5·2
Extract[2]	36·0	39·1

[1] *Determined by Procter's modification of Lowenthal's process.*

[2] *The percentage dissolved by treating a given quantity of tea with one hundred times its weight of boiling water and allowing it to infuse for* 10 *minutes.*

The following are the corresponding results obtained at the Imperial Institute for Indian and China teas:

	Material as received.	Material dried at 100° C.			
	Moisture.	Caffeine.	Tannin.	Ash.	Extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Indian teas (13 samples):					
Maximum	7·8	4·1	11·1	6·9	35·2
Minimum	6·4	3·6	6·9	5·4	27·4
Average	7·1	3·8	9·2	6·0	31·7
China teas (8 samples):					
Maximum	9·2	3·7	9·3	8·2	27·2
Minimum	7·1	2·6	3·3	6·0	19·0
Average	8·2	3·0	5·2	6·8	24·3

From a comparison with these figures it will be seen that the present sample of Uganda tea is rich in caffeine, tannin, and extractive matter, and that in this respect it resembles Indian rather than China tea.

The sample was submitted to a firm of brokers, who reported that it represented a blackish, rather bold and mixed, unassorted tea, with some white tip. The liquor was of fair strength, with some quality, but was very light in colour; and the infused tea, whilst generally of good colour, was uneven, with some greenish leaves. The brokers stated that the value of the tea was uncertain, but might be nominally about 8½*d.* to 9*d.* per lb. in London (January 1914).

The brokers mentioned that this tea was very similar in style and appearance to a variety which used to be received from Java some years ago, called "Flowery Pekoe," but they added that the present sample had evidently not been graded. Compared with that of Indian, Ceylon, and Java teas, the liquor was in their opinion too thin to attract the

competition of most buyers in London. They considered that the tea might with advantage be given a longer fermentation and also a heavier rolling, which would tend to increase the colour and strength of the liquor.

The firm added that the sample showed very fair manufacture, and if the suggestions made above were acted upon, they were of opinion that quite a satisfactory price would be realised in London, provided the tea came forward in marketable quantities of say not less than 20 chests at a time, each weighing 90 to 100 lb. net, or twice the number of half-chests averaging about 50 lb. net.

Two further samples of tea which had been fermented for a longer period than the previous sample were received from Kampala in January 1914.

They were as follows:

No. 1, "*Golden Tip.*"—Dried, rolled tea, clean and in good condition, and varying from pale brown to black in colour, a large proportion of the paler leaf being present.

No. 2, "*Broken Leaf.*"—Dried, rolled, black tea, mostly composed of broken leaf, and containing a small proportion of powder.

The teas, as received, were examined with the following results, compared with the previous sample from Uganda:

	No. 1. Golden Tip.	No. 2. Broken Leaf.	Previous sample.
	Per cent.	*Per cent.*	*Per cent.*
Moisture . . .	8·8	8·8	8·05
Caffeine . . .	4·90	3·85	3·67
Tannin	12·6	15·5	9·5
Ash	4·2	4·8	4·76
Extract	35·2	35·0	36·0

From the foregoing results it is seen that sample No. 1 contained a high percentage of caffeine, the average amount for Indian or Ceylon teas being about 3·5 to 4·0 per cent. In other respects the tea is of normal composition, though the percentage of tannin is rather higher than usual.

The analysis of sample No. 2 shows it to be of normal composition, and to resemble closely the previous sample of Uganda tea examined at the Imperial Institute, except as regards the percentage of tannin. The amount of this constituent appears to have been considerably increased by

the longer fermentation to which the leaf had been subjected as compared with the previous sample.

The samples were submitted to a firm of brokers, who valued No. 1 at about 1*s.* 4*d.* and No. 2 at about 8*d.* per lb. in London (August 1914). They added that the "Golden Tip" leaf, No. 1, was a somewhat fancy article, which they considered could only be produced in small quantities.

The firm stated that the longer fermentation to which these teas had been subjected, as compared with the earlier sample from Uganda, had resulted in some improvement in the colour of the liquor, but there is still a lack of strength in comparison with Indian and Ceylon teas. They suggested that this defect might be remedied by harder rolling.

East Africa Protectorate

Tea was first grown in the East Africa Protectorate on an estate at Limoru in 1904, from seed imported from India. The plants grew well, and localities similar to Limoru, where the rainfall is 60 in. or over in a normal year, and the air cool, seem well adapted for tea planting.

A sample of tea grown on this estate, and prepared by hand, was examined at the Imperial Institute in 1909.

It was black tea of good aroma, and was analysed with the following results, compared with the average figures for a number of Indian and China teas examined at the Imperial Institute (see p. 541):

	Present sample. *Per cent.*	Average of Indian teas. *Per cent.*	Average of China teas. *Per cent.*
Moisture	8·6	7·1	8·2
Caffeine	5·0	3·8	3·0
Tannin	9·6	9·2	5·2
Ash	4·8	6·0	6·8
Extract	33·9	31·7	24·3

All the above percentages, except the "moisture," are calculated on the material dried at 100° C.

The results show that this tea from the East Africa Protectorate resembles Indian tea in the amount of extractive matter and tannin present, but that it contains an unusually high percentage of caffeine.

The tea was submitted to a firm of brokers, who

reported that it had on the whole been carefully prepared, that the twist of the leaf was good, but that the leaves were irregular in size, being unsorted. The liquor obtained on infusion was found to be of very fair quality, and the tea generally resembled that from several Ceylon gardens.

The tea was valued at from 6½*d.* to 7*d.* per lb. (March 1909).

The investigation shows that tea of good saleable character can be grown in the Limoru district of the East Africa Protectorate with prospects of success.

Fiji

A sample of tea, described as Orange Pekoe from the Wainunu Estate, Fiji, was received for examination in July 1909. It was a black tea containing some tip and was of fairly satisfactory appearance. The leaf was of a useful size but somewhat broken.

A chemical examination of the tea gave the following results, which are compared in the table with corresponding figures for Indian and China teas previously investigated at the Imperial Institute (see p. 541).

	Present sample.		Average of Indian teas.	Average of China teas.
	Material as received.	Material dried at 100° C.	Material dried at 100° C.	Material dried at 100° C.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	10·6	—	—	—
Caffeine . .	2·8	3·1	3·8	3·0
Tannin . .	7·9	8·9	9·2	5·2
Ash . . .	4·6	5·2	6·0	6·8
Extract . .	26·2	29·3	31·7	24·3

It will be seen from these figures that the tea from Fiji resembles the Indian teas in the percentage of tannin present, but that it contains a smaller amount of caffeine, agreeing in the latter respect with the China teas. The percentage of "extract" is between those given by the Indian and China teas.

The firing of this tea appeared to have been carried out at rather too high a temperature, with the result that the sample smelt rather scorched. The infusion had but little strength, was light in colour, and tasted slightly

burnt or "over-fired." The infused leaf was too dark and mixed.

The tea was submitted to commercial experts, who valued it at 7½*d.* per lb. (December 1909). They stated, however, that this valuation was based almost entirely on the appearance of the tea. For the reasons already mentioned, the "liquor" was regarded as unsatisfactory, and in this respect the tea could only be classed with inferior descriptions. A better product would no doubt be obtained with more careful preparation.

NUTS OF *CANARIUM* SPP.

DURING the last few years the nuts of species of *Canarium*, known as "pili" nuts, have come into prominence in the United States for dessert use. They are obtained largely from wild trees in the Philippine Islands, the most important species, according to the Chief of the Division of Horticulture, Manila, being *C. luzonicum*, the source of Manila elemi. The total exports of pili nuts from Manila in 1913 amounted to about 900 tons. Another species, *C. commune*, is cultivated in the Moluccas for the sake of its nuts, the kernels of which are eaten there as well as in Java and the Straits Settlements.

With a view to determining the value of *Canarium* kernels as a substitute for sweet almonds in confectionery, supplies of the nuts of *C. commune* and *C. rufum* were obtained from the Straits Settlements as well as nuts of *C. Colophania* from Mauritius. The results of examination of the nuts are given below.

Canarium commune *Nuts from the Straits Settlements.*—The sample consisted of nuts measuring about 1⅜ in. in length and ⅞ in. in diameter, somewhat resembling Spanish chestnuts in shape, and pale brownish-grey to dark brown in colour. The shells were about ⅛ in. in thickness, and very hard.

The nuts consisted of shell 87·1 per cent., and kernel 12·9 per cent. Most of them contained at least two kernels, about 30 per cent. contained three kernels, and a few contained only one. The kernels had a chocolate-coloured

coat, enclosing a cream-coloured interior which had a pleasant oily taste.

Canarium rufum *Nuts from the Straits Settlements.*—These nuts had a brown, tough outer coat of shrunken appearance, about $\frac{1}{8}$ in. thick, which in a few cases had partially rotted away. The outer coat enclosed a three-sided, hard nut, tapering to a point at each end, of a brown colour, and about $1\frac{3}{4}$ in. long and $\frac{3}{4}$ in. thick. Embedded in the woody shell were three slender kernels about 1 in. long, and from $\frac{1}{8}$ to $\frac{1}{4}$ in. thick, and having a brown seed-coat. The kernels were white and oily, and had a pleasant taste.

The nuts consisted of husk 95·3 per cent., and kernel 4·7 per cent. (seed-coat 1·6 per cent., interior 3·1 per cent.).

The higher percentage of husk in the present sample is, to a certain extent, due to the presence of the outer coat of the fruit, which had been removed in the case of the *C. commune* nuts.

Canarium Colophania *Nuts from Mauritius.*—These nuts consisted of a comparatively small kernel surrounded by a thick hard shell. The average dimensions of the whole nuts were $1\frac{1}{2}$ by $\frac{5}{8}$ in., and of the kernels $\frac{3}{4}$ by $\frac{3}{16}$ in. The nuts were composed of shell 96 per cent., and kernel 4 per cent. The kernels possessed a pleasant taste.

The kernels of these *Canarium* nuts were analysed with the following results; in the case of *C. commune* and *C. rufum*, the seed-coats were removed before analysis:

	C. commune.	*C. rufum.*	*C. Colophania.*
	Per cent.	*Per cent.*	*Per cent.*
Moisture	2·9	3·9	4·2
Crude proteins	13·5	16·4	15·9
Consisting of:			
True proteins	12·9	15·5	15·3
Other nitrogenous substances	0·6	0·9	0·6
Fat	72·3	70·5	64·6
Starch, etc.	7·4	4·2	9·0
Fibre	trace	trace	2·1
Ash	3·9	5·0	4·2
Nutrient ratio[1]	1 : 12·3	1 : 10·1	1 : 10
Food units[2]	221·9	221·4	210·5

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The kernels of these nuts have a very high food value, and in the case of *C. commune* and *C. rufum* the proportion of fat is large, viz. 72·3 and 70·5 per cent., respectively, as compared with about 65 per cent. in the case of walnuts, filberts, and hazel nuts. Owing to the thickness of the shell and its extreme hardness the nuts are unlikely to be of any commercial value for export. The proportion of shell in the nuts was greatest in the case of those of *C. Colophania*, viz. 96 per cent., and at the same time they were more difficult to break.

If the nuts were shelled locally and the whole kernels alone exported, in good fresh condition, the product might perhaps find a market in European confectionery; but the kernels have no special advantage in taste over the kinds already used for this purpose, and as the nuts yield only a small proportion of kernels the extraction might be unremunerative at the price obtainable. A further obstacle to the commercial utilisation of the *C. Colophania* nuts is the fact that the tree is stated to produce fruits very irregularly in Mauritius.

BEANS FROM BRITISH WEST AFRICA

IN a previous number of this BULLETIN (1913, **11**, 230) an account was given of the results of examination at the Imperial Institute of a number of samples of beans from West Africa and elsewhere, and reference was made therein to earlier articles on the same subject. Since the former article was published, samples of beans from Sierra Leone, the Gold Coast, and Nigeria have been examined, and these are dealt with in the following pages.

VIGNA CATJANG BEANS FROM SIERRA LEONE

A sample of "Kroo" beans, identified at the Royal Botanic Gardens, Kew, as *Vigna Catjang*, was received from Sierra Leone in April 1913.

They were small rounded beans about ¼ in. in diameter, plump on the whole, of fairly good appearance, and mostly pale pinkish-brown in colour with an admix-

ture of darker beans. The beans had a firm, cream coloured interior, and the taste was not unpleasant. The sample had suffered very slightly from insect attack, but was otherwise clean and free from extraneous matter.

The beans were analysed with the following results compared with a sample of *V. Catjang* beans from Hong Kong previously examined at the Imperial Institute (see this BULLETIN, 1912, **10**, 236), and with Indian Catjang beans as recorded by Church.

	Present sample.	Previous samples. From Hong Kong.	From India.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·3	11·7	12·7
Crude proteins	24·3	22·0	23·1
Consisting of:			
True proteins	22·3	20·4	—
Other nitrogenous substances	2·0	1·6	—
Fat	1·1	1·2	1·1
Starch, etc.	55·2	58·0	55·3
Fibre	4·9	3·8	4·2
Ash	3·2	3·2	3·6
Nutrient ratio [1]	1 : 2·4	1 : 2·7	1 : 2·5
Food units [2]	118·7	116·2	115·8

[1] *The ratio between the percentage of crude proteins and the sum of the percentages of starch and fat, the latter being first converted into its starch equivalent.*

[2] *The total obtained by adding the percentage of starch to 2·5 times the sum of the percentages of fat and crude proteins.*

The beans contained no alkaloids or cyanogenetic glucosides.

The beans were submitted to a firm of merchants in London, who reported that they could only be used in the United Kingdom as a feeding-stuff for cattle, for which purpose they would be worth from £5 10*s.* to £5 15*s.* per ton c.i.f. (July 1913). The firm added that the beans would probably be difficult to sell at first, but that when better known they would probably realise higher prices.

PHASEOLUS LUNATUS BEANS FROM SIERRA LEONE

Two samples of "Towé" beans, identified at the Royal Botanic Gardens, Kew, as *Phaseolus lunatus*, were received from Sierra Leone in August 1913.

No. 1.—These beans, which measured approximately

1 by ⅝ in., were white, with black or very dark reddish-brown markings. The interior was of cream colour and possessed a not unpleasant taste. The sample was in good condition, clean, and free from insect attack.

No. 2.—Flat, kidney-shaped beans, measuring about 1 by ⅝ in., of a pinkish-brown colour with faint grey and black markings. The interior was of cream colour, and had a not unpleasant taste. The sample was in good condition, clean, and free from insect attack.

The beans were analysed with the following results:

	No. 1. *Per cent.*	No. 2. *Per cent.*
Moisture	11·3	13·4
Crude proteins	22·9	23·4
Consisting of:		
True proteins	21·4	21·0
Other nitrogenous substances	1·5	2·4
Fat	0·8	0·8
Starch, etc.	55·7	55·8
Fibre	4·8	3·8
Ash	2·7	2·8
Nutrient ratio	1 : 2·5	1 : 2·5
Food units	115	116

The beans contained no alkaloids, but on hydrolysis No. 1 yielded 0·025 per cent. and No. 2 0·03 per cent. of prussic acid.

In view of the fact that both these samples of towé beans yielded considerable quantities of prussic acid, they could not be recommended as suitable for local consumption in Sierra Leone or for export to the United Kingdom.

P. lunatus beans are well known to yield prussic acid. Full information on this subject will be found in previous articles in this BULLETIN (1903, **1**, 15, 112; 1905, **3**, 373; 1906, **4**, 334; 1912, **10**, 655).

SWORD BEANS (*CANAVALIA ENSIFORMIS*) FROM THE GOLD COAST

A sample of beans identified at the Royal Botanic Gardens, Kew, as *Canavalia ensiformis*, DC., was received from the Gold Coast in December 1913. The beans were stated to have been obtained from plants found growing on the sand along the sea-coast.

The sample consisted of irregularly shaped, more or less oval beans, measuring about ⅜ in. in width and ⅝ in. in length. The seed-coat was mottled, and varied in colour from pale to dark greenish-brown, whilst the husk was hard and brittle. Internally the beans were cream-coloured.

The beans were analysed with the following results, compared with a sample of sword beans (*C. ensiformis*) from British Honduras, examined at the Imperial Institute (see this BULLETIN, 1913, **11**, 242).

	Present sample. *Per cent.*	Sword beans from British Honduras. *Per cent.*
Moisture	8·2	14·4
Crude proteins	27·4	25·0
Consisting of:		
True proteins	17·5	—
Other nitrogenous substances	9·9	—
Fat	1·3	2·7
Starch, etc.	45·7	48·4
Fibre	14·7	6·8
Ash	2·7	2·7
Nutrient ratio	1 : 1·8	1 : 2·2
Food units	117·4	117

The beans contained no alkaloids or cyanogenetic glucosides.

These beans have a fairly high food value, and in particular are rich in proteins.

The samples of *C. ensiformis* beans examined at the Imperial Institute have not been found to contain any alkaloids or cyanogenetic glucosides, but it may be mentioned that the beans are stated to be looked upon with suspicion in Mauritius and elsewhere as being poisonous. This has apparently not been confirmed, but in view of the suspicion which appears to exist regarding the beans it would be necessary to carry out preliminary feeding trials before they could be recommended as a feeding-stuff.

Canavalia obtusifolia Beans from the Gold Coast

A sample of beans grown at Tamale, Northern Territories, Gold Coast, was received in July 1914. Specimens of the beans were submitted to the Director,

Royal Botanic Gardens, Kew, who stated that they were apparently *Canavalia obtusifolia.*

The beans, which were of a deep pink colour, were about 1⅓ in. long, ¾ in. wide, and ⅝ in. thick, and of an oval shape, tapering slightly at one end. The husk was tough and could be easily separated. The interior was cream-coloured, of a firm mealy consistency, and possessed a fairly agreeable taste. The average weight of the beans was 4·5 grams. The sample also included a pod about 6½ in. long, 1½ in. wide, and 1 in. thick. It was tough, somewhat wrinkled, and of a straw-yellow colour, and contained 5 beans.

The beans were analysed with the following results:

	Per cent.
Moisture	10·9
Crude proteins	22·0
Consisting of:	
True proteins	14·8
Other nitrogenous substances	7·2
Fat	1·9
Starch, etc.	54·5
Fibre	8·1
Ash	2·6
Nutrient ratio	1 : 2·6
Food units	114

The beans contained no alkaloids or cyanogenetic glucosides.

From the above analysis the beans are seen to have a fairly high food value, and to be generally similar in composition to the preceding sample of sword beans, though they contain less protein.

As a feeding-stuff for cattle, these beans are very promising, but, as in the case of the preceding sample of sword beans, it would be advisable to ascertain their suitability for this purpose by actual feeding trials.

Beans from Nigeria

A sample of beans collected at Lafia Nufawa, in Bassa Province, Nigeria, was received in March 1913.

The beans were kidney shaped, about ¾ in. long and ½ in. broad, clean and in good condition. They were white

in colour, but showed yellowish-brown stains, which were irregularly distributed, but occurred chiefly along the edge.

The beans were analysed with the following results, compared with Indian haricot beans as recorded by Church.

	Present sample. *Per cent.*	Indian haricot beans. *Per cent.*
Moisture	8·7	14·0
Crude proteins	22·5	23·0
Consisting of:		
True proteins	21·0	—
Other nitrogenous substances	1·5	—
Fat	0·7	2·3
Starch, etc.	61·6	52·3
Fibre	2·9	5·5
Ash	3·6	2·9
Nutrient ratio	1 : 2·8	1 : 2·5
Food units	120	116

The beans contained no alkaloids or cyanogenetic glucosides.

The beans were submitted to a firm of brokers, who reported that their value was very seriously reduced by the yellowish-brown stains referred to above, and that the present sample would be worth only about 6*s.* per cwt. If, however, the beans could be supplied without these stains they would be worth 12*s.* to 14*s.* per cwt. in London (September 1913).

BARLEY FROM CYPRUS

BARLEY is cultivated on a fairly extensive scale in Cyprus, the total production in 1913–14 amounting to 271,084 quarters. The exports in that year were 40,008 quarters, valued at £37,747. Of this amount 36,845 quarters, valued at £34,670, went to Egypt, and 2,125 quarters, valued at £2,122, to the United Kingdom.

A sample of barley grown in Cyprus was received at the Imperial Institute for examination in May 1914.

It was desired to ascertain the suitability of the barley for malting purposes, and the price which it would be likely to realise in the United Kingdom.

The sample consisted of moderately hard, pale-coloured barley. The grains were of medium size and fairly plump. The barley was clean and of good appearance, but it had suffered from insect attack, about 16 per cent. of the grains being affected. The grains, when cut across, were on the whole somewhat flinty.

The barley, as received at the Imperial Institute, was examined with the following results:

	Per cent.
Germinating power (4 days)	86
,, ,, (9 days)	89
Moisture	11·2
Nitrogen:	
Total	1·2
Albuminoid	1·0
Fat	1·5
Average weight of 1,000 grains	58 grams.

The grains which did not germinate after nine days, amounting to 11 per cent. of the total, had been attacked by insects.

The sample was submitted to an expert in London, who reported that it represented a good malting barley, which should be readily saleable in the United Kingdom if it could be marketed in commercial quantities. The current value of consignments equal to the sample would be about 30*s.* per quarter of 448 lb. on rail in London (July 1914). The expert, however, expressed a doubt as to whether the quality of shipments of the barley could be kept up to the standard of the present sample.

This barley contained a low percentage of nitrogen, which is a good feature in a malting barley, but owing to the attacks of insects the germinating power of the present sample is rather low.

GENERAL NOTICES RESPECTING ECONOMIC PRODUCTS AND THEIR DEVELOPMENT

NEW DEVELOPMENTS IN THE WORK OF THE IMPERIAL INSTITUTE

I. Formation of a Technical Information Bureau

For some years past a steadily increasing stream of enquiries has been received by the Imperial Institute from manufacturers, merchants, and others in Great Britain, India, and the Colonies. These enquiries relate principally to new sources of supply of raw materials, methods of utilising new products from the Colonies and India, or to new or little known processes and machinery for industrial purposes. The number of these enquiries has now become so great that the Secretary of State for the Colonies has authorised the formation of a Technical Information Bureau at the Institute for dealing with them.

This Bureau has already been at work for some months. It is a special branch of the Scientific and Technical Research Department, and is mainly staffed by experts who have had the advantage of experience in the work of that Department, which is carried on in communication with producers in the Colonies and with manufacturers and users of raw materials in this country.

The present is a specially opportune time for the formation of such a Bureau, since the paralysis of German and Austrian trade and industry opens up opportunities for the development of many industries in this country and in the Colonies which have hitherto been monopolised by Germany. Apart from its general activity the Bureau is already playing a part in this special work, and some instances may be given to illustrate the kind of assistance it is prepared to render.

A very important question at the present moment is that of the supply of potash salts, which are essential in certain branches of glass and soap manufacture and for the preparation of a large number of chemicals and

manures. Germany has for many years had a practical monopoly of this industry, owing to her possession of the great potash mines of Stassfurt. The only country which has made any attempt to break this monopoly is the United States. The possible sources of supply of potash to Great Britain just now are small, being limited to imports of nitre from India, potash made from Irish and Scotch kelp, and a little obtained as by-products from wool and waste timber. Numerous enquiries have been received at the Imperial Institute from British manufacturers on this subject, and they have been placed in communication with firms who may be able to meet their requirements to some extent. It is quite certain, however, that the existing supplies outside Germany are quite inadequate to meet all the demands, and the Bureau is preparing a statement as to the sources of potash, which will include some hitherto almost untouched for industrial purposes. The necessary enquiries will occupy some time, but it is hoped to issue the statement shortly.

An equally important matter is that of finding markets in this country for the immense quantities of raw materials from India and the Colonies formerly exported to Germany and to other countries of the enemy. As examples of these materials, palm kernels and copra may be mentioned. These products have been exported on a very large scale to Germany to be worked up into oil and feeding-cake, the former being then largely exported to England. There is no reason why this industry should not be transferred to such great oil-seed crushing centres as Hull and Liverpool, and the Bureau is prepared to place manufacturers in communication with merchants dealing in palm kernels, copra, and other raw materials of all kinds.

A statement giving full information regarding the German palm kernel industry was published in the last issue of the BULLETIN, whilst the present number contains further information on the subject (p. 577) as well as a comprehensive article on copra and its utilisation (p. 557).

Similar detailed statements, prepared in the Technical Information Bureau, will be published in this BULLETIN

from time to time. In addition, special circulars calling attention to Colonial and Indian raw materials of technical interest to British manufacturers will be issued as required, and distributed to all manufacturers likely to be interested. The following circulars of this kind are now available:

1. New markets for British, Colonial, and Indian copra.

2. Wattle or mimosa bark for tanning.

Written enquiries for copies of these circulars and for information should be addressed to the Director, Imperial Institute, South Kensington, S.W., and marked "Technical Information Bureau."

II. The Conduct of Special Investigations and Enquiries for Manufacturers and Producers

Until recently the experimental investigations and analyses carried on by the Scientific and Technical Research Department of the Imperial Institute have been limited to subjects and materials submitted officially by British, Colonial, or Indian Government Departments.

Every year, however, a number of requests are received from manufacturers in the United Kingdom, and from planters and others in the Colonies and India, desiring to find openings for raw materials, for assistance in the investigation of the composition and value, and the methods of preparing or utilising raw materials, both mineral and vegetable. Wherever possible these enquirers are referred to professional experts who can give them the assistance they require, but in many cases this cannot be done. To meet these cases the Secretary of State for the Colonies has sanctioned a scheme whereby special analyses and investigations of this kind can be undertaken at the Imperial Institute for firms or private persons in any part of the Empire, on payment of appropriate charges.

All reports made under this scheme will be the property of the person or firm requesting them, and their contents will not be communicated or published in any form without the consent of those concerned.

All requests for such work should be addressed in writing to the Director, Imperial Institute, South Kensington, S.W.

THE INDUSTRIAL POSITION OF COPRA, COCONUT OIL, AND COCONUT CAKE

LARGE quantities of coconut oil are produced by natives in India, Ceylon, and elsewhere, whilst the dried kernels of the coconut, known as copra, are largely exported to Europe, and the oil extracted by modern milling methods. Prior to the war the chief countries importing copra were Germany and France, but owing to the complete cessation of trade from British possessions to the former country, as well as to Austria-Hungary, large quantities of copra from Ceylon, India, the Federated Malay States, and other countries have become available for use elsewhere, and in the present article attention is called to the magnitude of this trade and to the desirability of British merchants and manufacturers securing a larger proportion of copra for industrial purposes in this country.

The quantities and values of the exports of copra from some of the more important producing countries are shown in the following table; the figures in each case are for the last year for which statistics are available:

	Year.	Quantity. *cwts.*	Value. £
British Territories:			
Ceylon	1913	1,117,292	1,397,284
India	1913-14	763,832	1,039,826
Federated Malay States	1913	185,753	211,043
Seychelles	1913	58,738	71,919
Tongan Islands Protectorate	1912	222,400	209,567
Fiji Islands	1913	158,585	176,741
Papua	1912-13	15,880	16,356
British Solomon Islands	1912-13	83,920	73,637
Gilbert and Ellice Islands Protectorate	1911	41,700	20,700
East Africa Protectorate	1912-13	31,283	31,956
Zanzibar	1913	—	216,842
Gold Coast	1913	12,589	14,291
Trinidad	1913	10,308	11,545
Foreign Territories:			
Philippine Islands	1913	1,618,080	1,988,692
Java	1913	1,556,000	—
Sumatra (East Coast)	1912	80,860	—
Celebes	1913	580,340	—

	Year.	Quantity. cwts.	Value. £
Indo-China	1912	157,074	95,783
New Caledonia	1912	53,173	64,850
French Oceania	1912	117,662	112,569
Samoa	1912	220,423	203,496
Bismarck Archipelago, German Solomon Islands, and German New Guinea	1912	223,814	202,603
East Carolines, Marshall Islands, and Nauru	1912	94,940	82,820
West Carolines, Pelew and Mariana Islands	1912	21,706	15,091
German East Africa	1912	83,468	78,132
Portuguese East Africa	1911	78,820	48,066

The following tables, giving the distribution of the exports of copra from British possessions, show that in many cases a very large proportion of the trade was with Germany; in the case of Ceylon no less than three-quarters of the exports went to Germany in 1913, and in the case of India in 1912–13 as much as four-fifths.

Ceylon

	1911.		1912.		1913.	
	cwts.	£	cwts.	£	cwts.	£
United Kingdom	10,503	9,382	9,996	10,804	1,500	2,001
India	56	27	—	—	163	244
Austria-Hungary	12,096	13,120	29,977	31,956	30,041	37,518
Belgium	14,508	14,439	4,020	2,445	18,000	23,422
Denmark	11,500	14,133	68,000	79,285	25,667	34,639
France	7,999	7,934	2,000	2,200	1,003	1,000
Germany	567,473	612,312	368,034	408,525	814,979	1,013,486
Holland	1,000	1,000	1,000	1,067	1,059	1,200
Roumania	—	—	—	—	4,000	5,600
Russia	191,171	200,341	131,042	135,893	220,880	278,174
United States	5,508	5,500	—	—	—	—
Total	821,814	878,188	614,089	672,175	1,117,292	1,397,284

India

	1910-11.		1911-12.		1912-13.	
	cwts.	£	cwts.	£	cwts.	£
United Kingdom	5,929	7,013	40,814	51,865	43,999	54,318
British Possessions	1,771	1,490	847	834	753	852
Russia	24,856	29,323	31,485	36,373	43,184	54,886
Germany	348,556	409,359	473,292	563,168	548,331	687,142
Holland	1,997	2,663	12,735	15,866	8,492	10,258
Belgium	11,300	13,250	25,485	29,718	13,904	15,889
France	54,401	61,994	48,490	56,920	26,049	32,367
Other countries	757	1,043	4,375	4,914	2,281	3,153
Total	449,627	526,135	637,523	759,658	686,993	858,865

Federated Malay States

Most of the copra exported from the Federated Malay Straits is sent to the Straits Settlements, but no information is available as to its ultimate destination. The total exports in recent years are as follows:

	cwts.	£
1910	149,726	139,326
1911	160,790	151,002
1912	154,204	152,036
1913	185,753	211,043

Protected Malay States

A considerable amount of copra is produced in the States of Perlis, Kelantan, Trengganu, and Johore. No statistics of the exports from the last-named State are available, but in 1912, 161,648 cwts., valued at £157,548, were imported into Singapore from Johore. The exports from the other States mentioned in the last year for which statistics are available were as follows:

	Year	*cwts.*	£
Perlis	1911	5,146	—
Kelantan	1912	90,995	89,176
Trengganu	1912	27,715	28,044

Straits Settlements

There is a very considerable transit trade in copra in the Straits Settlements, and large quantities are exported to Europe from Singapore and Penang. That shipped from the former port is derived mainly from the Netherland East Indies, Malay Peninsula, Philippine Islands, and Siam, whilst that shipped from Penang comes chiefly from the Netherland East Indies and Malay Peninsula. The total exports from Singapore and Penang in 1912 were as follows:

	Singapore.		Penang.	
	cwts.	£	*cwts.*	£
United Kingdom	41,774	45,205	11,431	14,308
Austria-Hungary	62,127	64,550	4,981	5,577
Belgium	28,600	30,081	1,001	1,027
Denmark	94,742	102,823	75,330	81,863
France	172,531	179,820	21,414	23,317
Germany	402,643	420,934	258,026	290,332
Russia	304,969	317,868	55,571	60,170
Other countries	72,257	74,965	3,010	2,648
Total	1,179,643	1,236,246	430,764	479,242

British North Borneo

No information is available as to the destination of the copra exported from British North Borneo. The quantity and value of the total exports in recent years are as follows:

	cwts.	£
1910	9,237	7,331
1911	10,571	8,532
1912	11,200	9,076
1913	12,884	11,504

Seychelles

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	2,210	2,107	799	813	10,521	14,127
France	37,326	37,995	46,083	46,619	44,106	52,772
Germany	11,414	11,325	6,963	5,981	2,368	2,757
Other countries	20	19	—	—	1,743	2,263
Total	50,970	51,446	53,845	53,413	58,738	71,919

Tongan Islands Protectorate (Friendly Islands)

	cwts.	£
1910	259,960	232,866
1911	254,420	231,479
1912	222,400	209,567

No particulars are available as to the destination of the exports in 1911 and 1912, but in 1910 about one quarter of the total output was shipped to Europe, the balance going to Australia, with the exception of a small quantity which went to New Zealand.

Fiji Islands

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	—	—	49,099	45,354	34,747	36,518
Australia	257,814	233,915	207,841	180,780	122,352	138,663
New Zealand	68,916	60,330	16,230	14,899	—	—
Canada	—	—	1,040	1,040	—	—
United States	—	—	—	—	1,483	1,557
Japan	—	—	—	—	3	3
Total	326,730	294,245	274,210	242,073	158,585	176,741

Papua

No information is available as to the destination of the copra exported from Papua. The total exports in recent years are as follows:

	cwts.	£
1910–11	21,204	17,837
1911–12	19,860	19,368
1912–13	15,880	16,356

British Solomon Islands

The total exports of copra from the British Solomon Islands in recent years are given in the following table. No information is available as to the countries of destination.

	cwts.	£
1910–11	80,600	68,999
1911–12	71,740	55,953
1912–13	83,920	73,637

Gilbert and Ellice Islands Protectorate

The estimated total exports of copra in 1910 amounted to 60,000 cwts., valued at £30,000. In 1911 the exports were 41,400 cwts., valued at £20,700.

East Africa Protectorate

	1910–11.		1911–12.		1912–13.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	—	—	403	412	405	468
Zanzibar	5,402	4,347	3,534	2,966	3,624	3,620
France	30,207	25,387	27,780	24,677	26,524	27,151
Other countries	1,270	874	—	—	730	717
Total	36,879	30,608	31,717	28,055	31,283	31,956

Zanzibar

	1911. £	1912. £	1913. £
United Kingdom	25	298	—
France	199,155	189,915	215,063
Germany	2,603	624	1,779
Italy	1,325	—	—
Other countries	838	100	—
Total	203,946	190,937	216,842

Of the total exports from Zanzibar in 1913, 142,019 cwts., valued at £162,632, were produced in the Protectorate, most of the remainder being derived from German East Africa.

Gold Coast

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	54	36	99½	69	45	39
France	13,950	11,987	11,617	11,256	12,394	14,136
Germany	1,593	1,234	679	514	150	116
United States	—	—	2½	2	—	—
Total	15,597	13,257	12,398	11,841	12,589	14,291

Nigeria

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	2	1½	28	28	203	203
French Possessions	1,740	1,542	825	740	—	—
Germany	196	129	1,041	861	1,732	1,688
Total	1,938	1,672½	1,894	1,629	1,935	1,891

Trinidad

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	10,068	8,772	9,323	10,138	7,979	8,936
Germany	3,523	3,216	13,101	12,298	1,637	1,834
United States	1,249	1,276	5,793	6,290	692	775
Total	14,840	13,264	28,217	28,726	10,308	11,545

Jamaica

	1910.		1911.		1912.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	286	294	199	263	408	610
Germany	—	—	—	—	4	5
United States	—	—	—	—	10	10
Total	286	294	199	263	422	625

British Guiana

	1910-11.		1911-12.		1912-13.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	584	470	1,426	1,364	1,143	1,101
British West Indies	—	—	—	—	1½	1½
Denmark	113	62	—	—	—	—
Germany	—	—	223	207	—	—
United States	21	20	—	—	4½	5
Total	718	552	1,649	1,571	1,149	1,107½

Small quantities of copra are also exported from some other British Possessions, the total exports in each case in 1912 being as follows:

	cwts.	£
Mauritius	167	86
Grenada	252	182
St. Lucia	69	68
British Honduras	18	8½

Figures for the total imports of copra to Germany are not available, but as Harburg near Hamburg is the chief centre of the German oil-seed crushing industry it is probable that the figures for the latter port represent nearly the total German imports.

Imports of Copra in 1913 *to Hamburg and Austria-Hungary*

	Quantity, metric tons (2,204 lb.).
Hamburg:	
Imports from all sources	230,395
„ „ British Possessions	124,434
Austria-Hungary:	
Imports from all sources	33,604
„ „ British Possessions	29,177

The details of the imports from the British Empire are as follows:

Imports of Copra in 1913 *to Hamburg and Austria-Hungary from the British Empire*

	Hamburg, metric tons (2,204 lb.).	Austria-Hungary, metric tons (2,204 lb.).
United Kingdom	225	—
British Central and South America	195	—
British Africa	(not given)	774
British East Indies	112,341	22,104
Australia	10,653	6,299
British South Sea Islands	1,020	
	124,434	29,177

These figures are not quite complete. Some imports from British West Africa reach Hamburg, but are not separately shown in the returns for that port. The imports from Australia to Austria-Hungary include 608 metric tons from British Australia, and 5,691 metric tons described merely as from Australia, which probably includes some from foreign possessions in the Pacific Ocean.

The quantity of British copra for which a new market must be found may therefore be taken as about 153,611 metric tons.

It seems likely that a considerable proportion of this can be taken by the United Kingdom. The copra imported into Germany and Austria-Hungary is used for the production of oil (coconut oil) and feeding-cake (coconut cake). Of the coconut oil expressed from copra in or near Hamburg in 1913, the quantity exported as coconut oil amounted to 40,966 metric tons, of which 30,236 metric tons was sent to the United Kingdom and 5,261 metric tons to Norway and Sweden, the next largest purchasers. Copra is already expressed for oil in the United Kingdom and coconut oil is made both in Ceylon and India. The oil now produced in Hamburg for the United Kingdom might be expressed in Ceylon or India and shipped direct, or the copra might be exported to the United Kingdom and treated here instead of in Hamburg.

The exports of coconut oil from Germany to the United Kingdom before the war are stated to have been largely the produce of a British-owned factory in Germany.

The Trade Returns for the United Kingdom show that in 1913 this country also imported about 18,600 metric tons of coconut oil from foreign countries other than Germany. The total imports of foreign coconut oil to the United Kingdom in 1913 therefore amounted to about 49,000 metric tons, corresponding to about 82,000 tons of copra.

It is moreover certain that from all these foreign countries which export coconut oil to the United Kingdom, and especially from Germany, considerable quantities of coconut oil also reach this country in the form of margarine, vegetable butter, and prepared fats and foods of

various kinds. No definite figures can be suggested for the amount received in this way.

It is clear from the foregoing data that considerably more than half of the British copra hitherto exported to Germany and Austria-Hungary might be taken by the United Kingdom for home use, either in the form of copra or coconut oil. Ceylon and India produce both copra and coconut oil, so that these countries could probably divert their supplies in either form to the United Kingdom. It is understood moreover that firms crushing copra in the United Kingdom are now extending their plant so that their is a good prospect of the British market for copra being greatly enlarged.

In addition to the possibility of finding a market in the United Kingdom, there appears to be a considerable chance of the British Colonies and India securing a share of the French import trade in copra. In 1912 the total imports of copra into France were 153,506 metric tons. Of this 19,691 metric tons came from British Possessions, and 10,321 metric tons from French Colonies. Of the remainder 43,422 metric tons came from the Netherland East Indies and 72,964 metric tons from the Philippines. It ought to be possible for Ceylon, India, and the Federated Malay States to compete on favourable terms with the Netherland East Indies and the Philippines for this trade.

Apart from the United Kingdom and France the new markets available for British copra are small. In the case of the United States the imports of copra in 1913 amounted to 15,548 metric tons, of which 10,674 metric tons came from the Philippines, and the rest mainly from French, British, and German Possessions in the Pacific. The imports of coconut nut oil to the United States amounted in 1913 to 22,915 metric tons, of which about 18,000 metric tons came from Ceylon, India, the United Kingdom, and Australia, and the rest chiefly from France, Germany, and the Philippines.

In Holland it may be difficult to replace the imports from the Netherland East Indies by British copra and coconut oil, but there seems to be some possibility for the development of export to Denmark, Scandinavia, and Russia.

Uses and Value of Copra

The copra imported to Europe and elsewhere is used as a source of oil (coconut oil) and feeding-cake (copra or coconut cake). The methods of preparing copra have been dealt with already in this Bulletin in an article on the coconut and its commercial uses (1912, **10**, 274), and it is proposed to deal now merely with its utilisation and value. The copra exported from the different countries varies somewhat in quality; the values of the more important grades in London, Marseilles, and Hamburg are shown below:

	London (Jan. 21, 1915), per ton.	Marseilles (July 17, 1914), per 100 kilos.
	£ s. d.	frs.
Malabar	26 2 6	—
Ceylon	25 10 0	63
Malay and Straits	£24 0 0–£24 10s. 0	59·50
Zanzibar	—	59·50
Manila	23 12 6	58·50
Samoa	23 17 6	59·50
East Africa	24 5 0	—

Coconut Oil

As already mentioned, large quantities of coconut oil are prepared from the fresh kernels in Ceylon and India, the exports in recent years being as follows:

Exports of Coconut Oil from Ceylon

	1911.		1912.		1913.	
	cwts.	£	*cwts.*	£	*cwts.*	£
United Kingdom	258,664	448,868	167,586	294,393	150,650	307,326
British Possessions	2,120	3,679	1,789	3,143	2,261	4,612
Austria-Hungary	16,253	28,204	17,975	31,576	14,300	29,172
Belgium	10,247	17,782	2,804	4,926	4,407	8,990
France	119	206	—	—	5	10
Germany	16,960	29,431	5,306	9,321	1,712	3,493
Holland	2,038	3,537	1,441	2,531	3,116	6,357
India (other than British)	952	1,652	1,092	1,918	1,203	2,454
Italy	852	1,478	2,046	3,594	2,311	4,715
Mozambique	3,001	5,208	441	775	276	563
Norway	12,072	20,949	31,423	55,200	40,626	82,877
Russia	—	—	—	—	401	818
Sweden	3,998	6,938	3,779	6,638	3,411	6,958
United States	177,731	308,422	166,053	291,700	322,305	657,502
Other foreign countries	9	16	44	77	—	—
Total	505,016	876,370	401,779	705,792	546,984	1,115,847

Exports of Coconut Oil from India

	1910-11.		1911-12.		1912-13.	
	Gals.	£	*Gals.*	£	*Gals.*	£
United Kingdom	317,670	39,363	557,292	72,076	217,655	29,499
British Possessions	41,295	5,742	59,117	8,133	48,174	6,811
Sweden	191,171	21,763	316,295	40,998	99,385	13,217
Germany	711,434	84,208	584,251	65,469	163,940	20,929
Holland	30,887	3,590	60,306	7,772	39,337	5,017
Belgium	103,326	12,503	34,506	4,507	46,229	6,189
United States	485,567	58,575	477,487	62,080	327,899	43,644
Other foreign countries	53,258	6,899	75,849	9,777	26,875	3,715
Total	1,934,608	232,643	2,165,103	270,812	969,494	129,021

Nearly all the Indian oil is prepared in Madras, and particularly on the Malabar coast. The Cochin oil produced in the latter region is on the whole more carefully prepared than Ceylon oil, and consequently realises higher prices. The values of Cochin and Ceylon oils in London at the present time are £55 and £48 10*s.* per ton, respectively (February 1915).

The quality of the oil prepared by expression from copra in Europe, the United States, and elsewhere depends largely on the quality of the copra used. Sun-dried copra yields an oil of paler colour than kiln-dried copra, whilst that obtained from imperfectly dried copra is of higher acidity and inferior quality. The current value of London-expressed oil is £40 5*s.* per ton (February 1915). The oil content depends on the thoroughness with which the copra has been dried. Thus, sun-dried kernels contain about 50 per cent. of oil, kiln-dried kernels contain 63 to 65 per cent., and hot-air-dried copra up to as much as 74 per cent. The ground copra is expressed twice at a temperature of 55° to 60° C., the yield of oil from average copra being about 62 to 63 per cent.

At the average European temperature coconut oil is a solid fat, varying in colour from white to yellowish, according to the quality of the copra and the method of preparation. The unrefined oil prepared from the best quality copra possesses the characteristic smell and taste of the fresh coconut, but that obtained from the lower grades of copra is often rancid and disagreeable in smell and taste. By suitable refining methods, however, an

odourless and tasteless oil may be produced, and the refining of coconut oil for the production of edible fats is now an important industry. The following table gives the range of the principal constants of coconut oil.

Specific gravity at $\frac{99°\,C.}{15°\,C.}$		0·874
Iodine value	*per cent.*	8·0–10·0
Saponification value		246–268
Hehner value		82·4–90·5
Reichert-Meissl value		6·6– 7·5
Polenske value		18·0
Titer test		21·2° C.–25·2° C.

Refined coconut oil is used in the preparation of solid edible fats such as margarine, vegetable butters, cooking fats, and chocolate fats, as well as in the manufacture of cakes, biscuits, sweetmeats, etc. In order to obtain a fat of firmer consistence and higher melting point, a certain proportion of the liquid constituents of the oil ("coconut olein") is removed by expression. The "coconut stearin" which is left is used for the purposes indicated above, when obtained from high-grade oil, while that obtained from the lower grades is used for candle manufacture. The extent of the trade in coconut oil and the edible products obtained from it has already been referred to (see p. 564).

Feeding Trials with Coconut Cake and Meal

Coconut cake, which is left after expression of the oil from copra, is of value as a cattle food, either as such or when ground in the form of meal. The cake is usually of a pale brown colour. It has a pleasant nut-like smell and taste, and is readily eaten by all classes of animals. It is used largely in Germany as a feeding stuff for live-stock, but owing to its relatively high price in that country it is generally given only to milch cows.

Numerous feeding experiments with the cake or meal have been carried out in Germany, the United Kingdom, and elsewhere. In the case of milch cows the results almost without exception show that feeding with coconut cake increases the percentage of fat in the milk; its precise

effect on the milk yield, however, seems to be in some doubt. Hansson (*Fühling's Landw. Zeit.*, 1912, **61**, 337), in commenting on the results of feeding trials reported from several sources, concludes that coconut cake tends to increase milk secretion, and as a result of experiments carried out on milch goats in Germany it was concluded that the cake contains substances which exercise a stimulating effect on the mammary glands (*Landw. Vers. Stat.*, 1909, **71**, 373). Experiments carried out at the South-Eastern Agricultural College, Wye, however, showed that when coconut cake replaced other concentrated foods the quantity of milk produced was slightly decreased (*Journ. S.E. Agric. Coll.*, 1911, No. 20, p. 47), and similar results were obtained at the Midland Agricultural and Dairy College, Derby. In the latter experiment eight cows were fed on rations containing either coconut cake, undecorticated cotton-seed cake, or linseed cake. The total milk yield from the eight animals fed for a fortnight on each cake were as follows:

	lb.
Linseed cake	2,472½
Coconut cake	2,429
Undecorticated cotton-seed cake	2,428½

In these experiments, the live-weight increase was greatest during the period when coconut cake was used, whilst the butter produced during this period was better flavoured, of firmer texture, and appeared to possess better keeping qualities than in the other cases, whilst the results are stated to have been financially in favour of coconut cake. The fact that coconut cake tends to produce a firm butter was also proved in the feeding trials at Wye and in experiments in Germany. Coconut cake should therefore be of special value for feeding to milch cows during warm weather and for use with foods, such as crushed oats and maize, wheat bran, rice meal, rape, sesame, and sunflower seed cakes, all of which tend to produce a soft butter. The quantity fed to milch cows should not exceed 4½ to 5 lb. per head per day, as larger quantities tend to produce a hard butter with a tallowy taste.

According to the *Report of the Agricultural Experiment Station, California*, for 1895–96, coconut meal is "a much valued concentrated food and is finding more favour every year with the dairymen of California. Whilst not rating as high in flesh formers as either linseed or [decorticated] cotton seed meal, it appears in many cases to be more relished by the animals."

The feeding value of coconut cake as compared with linseed cake for fattening cattle was investigated by the Edinburgh and East of Scotland College of Agriculture in 1911–12. Each cake was fed at the rate of 4 lb. per head per day, the basal ration consisting of 4 lb. Bombay cotton cake, 90 lb. swedes, and 12 lb. oat straw. All the animals, with one exception, ate the coconut cake readily after it had been steeped in twice its weight of water, and this one exception took the allowance in the dry form quite readily. The beef produced was of high quality. From the results of the experiments it is concluded that the consuming value of coconut cake (*i.e.* the market value less the value of the manurial residues) is 62·6 per cent. of that of linseed cake (*Report* 27, 1912, *Edin. and E. of Scot. Coll. of Agric.*).

Coconut meal forms a valuable food for pigs and can be used with advantage to counteract the effect of other foods which tend to give a soft oily bacon. It is already used very extensively in some parts of Ireland for pig-feeding, but experiments carried out by the Department of Agriculture for Ireland in 1909-10 seemed to indicate that coconut meal is not worth the extra price paid for it over and above the price of the ordinary meals generally used for this purpose (*Journ. Dept. Agric. Ireland*, 1910–11, **11**, 303).

Coconut meal has also been shown to be of value for feeding horses. Experiments conducted by the French War Department some years ago showed that coconut meal was equal or even superior to the same weight of oats, whilst satisfactory results were obtained in the United States with yearlings and heavy-work horses, when either one half or the whole of the oats in the ration were replaced by an equal weight of a mixture

consisting of two parts coconut meal and one part ground nut meal (*Circ.* 168, 1911, *Bur. Anim. Indust., U.S. Dept. Agric.*).

From the results of the numerous feeding trials referred to in the preceding pages, the following conclusions may be drawn:

1. Coconut cake forms an excellent feeding-stuff for milch cows, when fed at the rate of 4½ lb. to 5 lb. per head per day. It tends to produce a firm butter and is thus especially well suited for feeding during warm weather and to counteract the effect of feeding stuffs which tend to give a soft butter. The results so far as its effect on the milk yield is concerned appear to be inconclusive, and further trials to elucidate this point are necessary.

2. The cake may be safely fed to fattening cattle at the rate of about 4 lb. per head per day, without detriment to the animal or the quality of the meat.

3. The meal is suitable as a food for pigs, but owing to its relatively high price compared with meals usually used for pig feeding, it is doubtful whether it could be employed profitably for this purpose.

4. With regard to the feeding value of coconut meal for horses, it has been shown that it can replace an equal weight of oats in a ration without adversely affecting the animal.

Composition and Value of Coconut Cake as compared with other Feeding-Cakes

In comparing the value of different feeding-stuffs, it is necessary to ascertain their composition, digestibility, "productive value," and the value of the manurial residues arising from their consumption. This subject is fully dealt with in *Leaflet No. 74 Bd. of Agric. and Fisheries*, and only the salient points are considered here.

The constituents of a feeding-stuff comprise water, crude proteins (albuminoids), fat, carbohydrates, crude fibre, and ash.

Water.—In the case of oil-cakes the amount of water present is of importance, as most of them easily undergo

decomposition if they contain more than about 14 per cent. A good cake should contain about 10 per cent. of water.

Crude Proteins.—Under this heading are included all the nitrogen-containing substances, the most important of which are the true proteins, whose chief function in the animal economy is to supply material for the formation of flesh or muscle. Proteins also help to maintain the heat of the animal and to supply energy, and any excess may be employed in the production of fat. The "crude proteins" also include small quantities of amides. The latter are greatly inferior in feeding value to true proteins; but as they are present only in very small quantities in oil-cakes, they can be left out of consideration in estimating the value of the latter, and the whole of the nitrogen-containing substances may be regarded as flesh-formers for present purposes.

Fat.—The chief function of fat is to supply heat to the animal body, but when sufficient has been consumed to maintain the temperature of the body, fats may be converted into animal fat, and so increase the body-weight.

Carbohydrates.—This term includes starch, sugar, mucilage, and some other similar substances. They are the most important sources of animal heat and energy, but for the former purpose fat is nearly two and a half times as valuable, weight for weight. When fed in large quantities the carbohydrates are capable of producing animal fat.

Crude Fibre.—This includes substances of a more or less woody nature, and consists essentially of cellulose mixed with highly indigestible matter.

Ash.—This includes mineral matter, such as potash, lime, phosphoric acid, etc., which form an integral part of the plant from which the feeding-stuff is derived, as well as impurities such as sand, dirt, etc. Oil-cakes as a rule contain an ample supply of the mineral constituents which are necessary to the animal, and the ash may therefore be left out of consideration in comparing their value.

The following table shows the composition of a sample

of English-made coconut cake compared with that of feeding-cakes in common use in this country.

Crude Nutrients

	Moisture.	Crude proteins.	Fat.	Carbohydrates (by difference).	Crude fibre.	Ash.	Nutrient ratio.	Food units.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*		
Coconut cake, English (expressed)[1]	8·5	24·5	8·3	39·8	12·8	6·1	1 : 2·42	122
Linseed cake, English made, average (expressed)[2]	11·16	29·50	9·50	35·54	9·10	5·20	1 : 1·94	133
Linseed meal (extracted)[2]	13·15	34·75	3·03	34·67	8·75	5·65	1 : 1·20	129
Decorticated cotton-seed meal, Atlantic Ports (expressed)[2]	7·40	42·37	10·16	25·86	7·06	7·15	1 : 1·16	157
Undecorticated cotton-seed cake, English made (expressed)[2]	13·75	24·62	6·56	29·28	21·19	4·60	1 : 1·67	107

[1] *Analysis made by the Agricultural Analyst for the County of Wilts* (1912).
[2] *Quoted from Smetham* ("*Journ. Roy. Lancs. Agric. Soc.*," 1914).

In discussing the feeding value of different kinds of cake it is desirable to decide on a unit of comparison which will take into account the food values of all the different constituents of a cake, and thus enable the total feeding value of one cake to be compared with that of another by a simple numerical ratio. Such a unit may be arrived at in the following way.

As the various food constituents have different functions to perform, it follows that they will not all be of equal value to the animal. In calculating the food value of a cake the crude proteins and fat may be regarded as two and half times as valuable as the carbohydrates. Consequently the food value (expressed in food units) may be calculated by adding two and a half times the sum of the percentages of crude proteins and fat to the percentage of carbohydrates. The figures thus obtained are shown

in column 9 of the table on page 573. They are quite useful in comparing different samples of the same kind of cake.

In comparing different kinds of cake the crude value so arrived at needs to be qualified by taking into account the different digestibilities of the similar constituents of different cakes: thus the proteins of linseed cake are different from the proteins of cotton-seed cake and have different digestibilities and therefore different food values to the animal fed with them. Further, in the case of those cakes which contain a comparatively large amount of indigestible fibre, the whole of the digestible constituents are not available for meat or milk production. In calculating the food value on this basis the proteins are taken as equal in value to the carbohydrates, but the fat as two and a half times as valuable, whilst the amount of crude fibre is also taken into consideration. The food value (expressed in food units) in this case is found by adding two and a half times the percentage of digestible fat to the percentages of digestible crude proteins, carbohydrates, and crude fibre, the indigestibility of the fibre being allowed for by deducting from the figure thus obtained one unit for every 3 per cent. of crude fibre present. The figures thus obtained are shown in the following table, which also shows the percentage of digestible nutrients in samples of cakes and meals.

Digestible Nutrients[1]

	Crude proteins. *Per cent.*	Fat. *Per cent.*	Carbo-hydrates. *Per cent.*	Crude fibre. *Per cent.*	Food units.
Coconut cake, English (expressed) . . .	19·1	8·1	33·0	8·1	76
Linseed cake, English made, average (expressed)	25·37	8·74	27·72	2·91	75
Linseed meal (extracted) .	29·19	2·88	28·45	4·7	67
Decorticated cotton-seed meal, Atlantic Ports (expressed) . . .	36·44	9·55	17·33	1·98	77
Undecorticated cotton-seed cake, English made (expressed) . . .	18·96	6·1	15·23	3·8	46

[1] *Calculated from the analyses shown in the preceding table* (*p.* 573), *using the digestibility coefficients of Kellner* ("*The Scientific Feeding of Animals*," 1909, *pp.* 387, 388).

It will be seen from the above table that when the digestibility of the constituents is taken into consideration, coconut cake compares favourably with cakes in common use for feeding purposes. Although containing less proteins, the high proportion of digestible carbohydrates and fibre bring up the total food units almost to the level of decorticated cotton-seed cake, and slightly above that of linseed cake.

In comparing the cost of the different cakes, allowance must be made for the manurial value of the residues arising from their consumption. If this be deducted from the current value, and the net cost so obtained be divided by the number of food units calculated on a digestibility basis as shown in the table on page 574, the net cost per food unit will be found. This figure will represent the price which the farmer pays for that part of the cake which is actually used for meat and milk production. The current value, value of the manurial residues, and the cost per food unit of coconut cake compared with linseed and cotton-seed cakes, are shown in the following table:

	Current value per ton.	Estimated value of manurial residues arising from the consumption of 1 ton of feeding-stuff.	Cost per food unit, per ton, calculated on the net value, *i.e.* the current value less the estimated value of the manurial residues.
Coconut cake (expressed).	£6 10*s.* to £7 according to quantity and position (London, November 1914).	£1 14*s.* 7*d.*	1*s.* 3*d.* to 1*s.* 4½*d.*
Linseed cake (expressed).	English, guaranteed 95 per cent. linseed, £8 12*s.* 6*d.* to £8 17*s.* 6*d.* (Hull, November 1914).	£2 4*s.* 4*d.*	1*s.* 8½*d.* to 1*s.* 9*d.*
Cotton-seed cake. 1. Decorticated.	American, £8 10*s.* to £8 12*s.* 6*d.* (Liverpool, November 1914).	£3 4*s.* 9*d.*	1*s.* 4½*d.* to 1*s.* 4¾*d.*
2. Undecorticated (both expressed).	English, £5 15*s.* to £6 5*s.* (Liverpool, November 1914).	£1 17*s.* 1*d.*	1*s.* 8*d.* to 1*s.* 10*d.*

It will be seen that when all the factors are taken into account coconut cake is cheaper than linseed or cotton-seed cakes at the rates prevailing recently, and that the difference in price per food unit per ton represents a considerable

advantage to the farmer who uses coconut cake in preference to linseed and undecorticated cotton-seed cakes.

Comparison of English and German Coconut Cakes

Since the crushing of copra was commenced in this country, cakes of higher feeding value have become available. The difference in the composition of cakes produced in England and Germany is fairly considerable, the chief feature being the comparatively low proportion of fibre in English cakes, as is shown in the following table:

	English.		German.
	1.	2.	(According to Kellner, *loc. cit.*).
	Per cent.	*Per cent.*	*Per cent.*
Moisture	8·5	9·85	10·5
Crude proteins	24·5	23·00	21·4
Fat	8·3	8·00	8·5
Carbohydrates	39·8	44·23	38·7
Fibre	12·8	9·22	14·7
Ash	6·1	5·70	6·2

The analyses of the English cakes have been supplied by the makers of the cakes; No. 1 was made by the Agricultural Analyst of the County of Wilts in 1912; No. 2 is a factory analysis. Samples of British-made coconut cakes may be seen in the Reference Collection of Standard Commercial Products in the Public Exhibition Galleries of the Imperial Institute.

The Trade in Coconut Cake

Particulars as to the extent of the trade in coconut cake and the amount at present employed for feeding purposes are difficult to obtain. Mr. E. W. Thompson, who has recently investigated the trade in cotton-seed products and their competitors in Northern Europe, on behalf of the United States Government, states that 71,000 metric tons of coconut cake were produced in Germany in 1912, of which 30,000 tons were consumed there (*Special Agents Series:* No. 84, *Bureau of Foreign and Domestic Commerce, U.S. Dept. of Commerce*). The exports of coconut cake from Ceylon in 1913 amounted to 236,692 cwts., valued at £72,910; the chief customers were Germany (157,895 cwts., of value £45,629) and Belgium (73,606 cwts., of value £25,677). In 1912–13, 128,074 cwts. of cake, valued at £41,463, were exported from India, and practically the whole of this was sent to Germany. According to Thompson, 12,000 tons of coconut cake were produced in the

United Kingdom in 1912, and 8,000 tons were exported; 9,400 tons were produced in, and 5,000 tons were exported from, the Netherlands in 1912; 10,500 tons were produced in Denmark in 1912, and practically the whole of this was exported. It has been estimated that about 64,000 tons of cake were produced in Marseilles in 1912; it is not exported to any extent from France.

PALM KERNEL CAKE AND MEAL: A NEW FEEDING-STUFF FOR LIVE-STOCK

THE last number of this BULLETIN (1914, **12**, 458) included an article on the "Trade in Palm Kernels," which called attention to the opportunity afforded to British manufacturers by the war to secure a large share of the industry of crushing palm kernels, which has hitherto been carried on in Germany. This article has aroused much interest, and from statements sent to the Imperial Institute by oil-seed crushers, who have already started working palm kernels, or are about to do so, it seems clear that a very large proportion of the palm kernels produced in British West Africa will in future be utilised in Great Britain. In this connection it is interesting to note that 1,600 tons of palm kernels, as well as 3,000 barrels of palm oil, were recently landed at Hull, being the first consignment shipped thence from West Africa.

Two products are obtained in crushing palm kernels, viz. palm kernel oil and palm kernel cake. There seems to be no doubt that the market already existing in this country can take all the palm kernel oil likely to be produced here, but it is by no means certain at present that it will be possible at once to sell all the British-made palm kernel cake in this country. This is not due to the absence of a large British demand for feeding-cakes, but to the fact that farmers in this country are averse to using feeding materials which are new to them. Palm kernel cake is a very popular feeding material in Germany, Holland, Denmark, and Scandinavia, but it is comparatively unknown in Great Britain, and in order that the palm kernel crushing industry may be successfully and per-

manently established in this country it is very desirable that palm kernel cake should be made equally popular with British farmers. Sir Owen Philipps, Chairman of the West African Section of the London Chamber of Commerce, has already arranged with a number of the British agricultural colleges to carry out feeding trials with palm kernel cake, and the reports from the colleges should be of great value in making the qualities of this material known to farmers.

In the previous article published in this BULLETIN the feeding value of palm kernel cake and meal was referred to, and analyses of these products, as made in Germany, were published. Since then the Imperial Institute has been provided by British manufacturers of palm kernel cake and meal with typical analyses of the products they make, and these are now given in the following tables; the German analyses of German-made cake and meal previously quoted are added for comparison. Table I shows the percentage of crude nutrients present, and Table II the amounts of digestible nutrients; the food units in each case are calculated by the methods referred to on pp. 573 and 574 respectively.

TABLE I

Crude Nutrients

	Palm kernel cake (expressed).				Palm kernel meal (extracted).	
	English.			German.	English.	German.
	1.	2.	3.	4.	5.	6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture . .	12·0	12·0	10·85	9·7	15·0	10·9
Crude proteins .	16·75	18·5	16·12	17·7	19·0	18·7
Fat . . .	7·07	5·5	6·17	8·6	2·0	1·6
Carbohydrates .	46·83	50·0	48·51	36·2	51·0	39·1
Crude fibre . .	13·55	10·0	14·80	23·8	9·0	25·4
Ash . . .	3·8	4·0	3·55	4·0	4·0	4·3
Food units . .	106	110	104	102	104	90

1. Factory analysis (1914).
2. Average of factory analyses taken over a period of three months (1914).
3. Lloyd (*Field*, November 14, 1914, p. 837) (1914).
4. Kellner (*Scientific Feeding of Animals*, p. 377) (1905).
5. Average of factory analyses taken over a period of three months (1914).
6. Kellner (*loc. cit.*).

TABLE II

Digestible Nutrients[1]

	Palm kernel cake (expressed).				Palm kernel meal (extracted).	
	English.			German.	English.	German.
	1.	2.	3.	4.	5.	6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Crude proteins .	12·56	13·88	12·09	13·28	18·05	17·77
Fat . . .	6·93	5·39	6·05	8·43	1·90	1·52
Carbohydrates .	36·06	38·50	37·35	27·87	47·94	36·75
Crude fibre . .	5·28	3·90	5·77	9·28	7·38	20·83
Food units . .	67	67	65	63	75	71

Calculated from the analyses shown in Table I, using the digestibility coefficients of Kellner (loc. cit., p. 388).

It is satisfactory to note that the British-made cakes and meal are without exception superior in quality to the German products. This is especially shown in the lower proportion of crude fibre (so-called indigestible fibre) present in the British cake and meal. Attention has been called to this point in a recent article in the *Journal of the Board of Agriculture* (1914, **21**, 697), where it is attributed to improved methods of crushing. It is, however, much more probable that it is due to the careful removal in the British mills of all fragments of palm-nut shells. The point of importance, however, is that the percentage of crude fibre is very low in the British products, with the result that the feeding value of the cake and meal is correspondingly increased.

Samples of British-made palm kernel cake and meal may be seen in the Reference Collection of Standard Commercial Products in the Public Exhibition Galleries of the Imperial Institute.

THE ECONOMIC RESOURCES OF THE GERMAN COLONIES

I. German East Africa

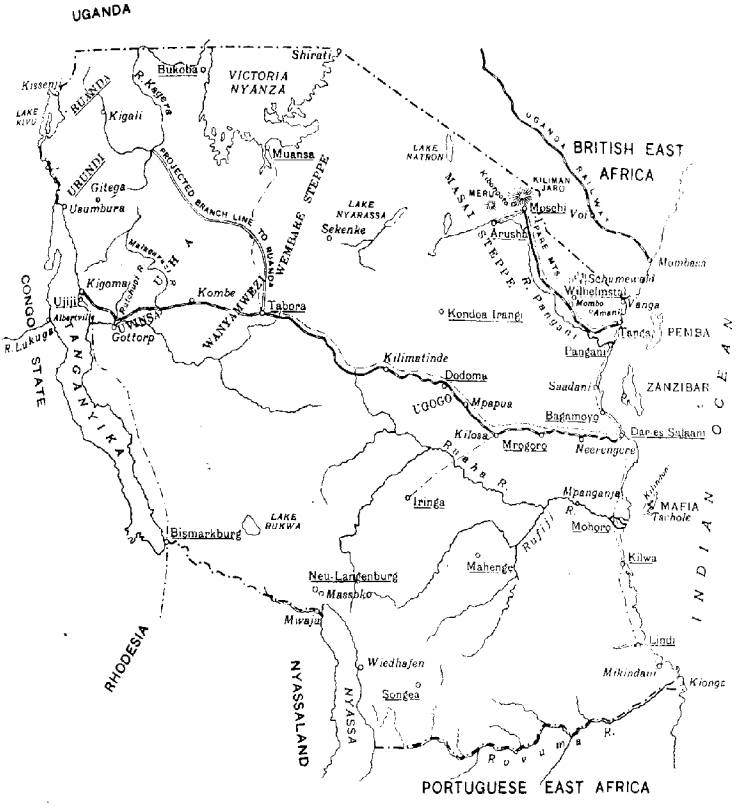
(With a Map)

In a previous number of this Bulletin (1913, **11**, 462) an account was given of the organisation of experimental work in agriculture in the German Colonies. In the present series of articles it is intended to deal with the economic resources of these colonies, with especial reference to the possibilities of further development, commencing with German East Africa.

The Protectorate of German East Africa extends from about 1° to 11° S., and from about 30° to 40° E., and has a total area of 384,169 square miles, *i.e.* more than three times the size of the United Kingdom, and about 30,000 square miles larger than the British East Africa Protectorate. It is bounded on the east by the Indian Ocean, on the south by Portuguese East Africa, on the south-west by Nyasaland and Rhodesia, on the west by the Belgian Congo, and on the north and north-east by Uganda and the British East Africa Protectorate. The coast-line extends from the mouth of the Umba to a few miles south of the mouth of the Rovuma, a distance of about 620 miles. Three large islands lie off the coast, viz. Pemba and Zanzibar, which form the British Protectorate of Zanzibar, and, further south, Mafia with an area of about 200 square miles, which forms part of German East Africa.

The country as a whole is elevated, the interior plateau of Central Africa ending more or less abruptly near the coast, leaving a coastal plain which in the north varies in width from ten to thirty miles, but broadens out further south. The average altitude of the plateau is between 3,000 and 4,000 ft. The highest points in the Protectorate are in the north-east, where the extinct volcano Kilimanjaro, the highest mountain in Africa, situated close to the boundary of British East Africa, rises to 19,321 ft., whilst a little to the west is Mount Meru

SKETCH MAP OF GERMAN EAST AFRICA.



REFERENCE

Railways.....

" projected or under construction.....

Telegraph Lines (apart from railway telegraph).....

Administrative Centre or Seat of Resident..... Dar-es-Salaam

Ordnance Survey Office, Southampton, 1914.

To accompany the article on German East Africa in the BULLETIN OF THE IMPERIAL INSTITUTE, 1914, Vol. XII. No. 4.

(14,955 ft.). Stretching south-eastwards from Kilimanjaro are the Pare and Usambara Mountains, the latter almost reaching the sea. To the south-west of the Usambara hills, and on the eastern edge of the plateau, are the mountainous regions of Nguru, Useguha, and Usagara. In the south-west of the Protectorate are the Livingstone Mountains, where the highest peak is over 9,000 ft.

Portions of the great lakes of Central Africa are included in the Protectorate, viz. the southern portion of Victoria Nyanza, the eastern shores of Lakes Kivu and Tanganyika, and the northern and north-eastern shores of Nyasa. Situated on a line running through the centre of the country from north-east to south-west, are lakes Natron, Nyarassa, and Rukwa.

The country is well watered. The chief rivers draining the plateau and flowing into the Indian Ocean are the Rufiji and the Rovuma. The latter is about 500 miles long and has its source in the mountains east of Nyasa; for the greater part of its length it forms the boundary between the Protectorate and Portuguese East Africa. The Rufiji is navigable by small steamers for about sixty miles from its mouth; whilst one of its southern tributaries, the Ulanga, is navigable almost throughout its whole course. Other rivers entering the Indian Ocean are the Pangani, which has its source in a glacier on Kilimanjaro, and the Wami and Kingani, both of which have their origin on mountains on the fringe of the plateau; none of these is navigable for more than a few miles from its mouth. Of the rivers which feed the great lakes the more important are the Mori and Kagera (Victoria Nyanza), Malagarasi (Tanganyika), Songwe and Ruhuhu (Nyasa), and Saisi and Rupa-Songwe (Rukwa). The Kagera, which is 400 miles long, forms the headwater of the Nile, and is navigable for seventy miles from its mouth.

The chief seaports, all of which have good harbours, are, going from north to south—Tanga, with a population of 6,000, Pangani (3,500), Bagamoyo (5,000), Dar-es-Salaam (24,000), the seat of the Government, Kilwa (5,000), and Lindi (4,000). The most important inland town is Tabora, which has a population of 37,000 and is situated at the

junction of the main caravan routes from the coast to Tanganyika, and from Victoria Nyanza to Nyasa. Other important inland towns are Korogwe, in the Usambara Mountains, and Morogoro, Kilosa, Mpapua, and Dodoma on the road from Dar-es-Salaam to Tanganyika. On the great lakes the chief towns or settlements are Shirati, Muansa, and Bukoba on Victoria Nyanza, Ujiji, Usumbura, and Bismarckburg on Tanganyika, and Old Langenburg and Wiedhafen on Nyasa.

For administrative purposes the Protectorate is divided into twenty-four districts, as follows (the figures in parenthesis show the native population on March 31, 1913, those in italics being the density per square kilometre). Along the coast from north to south are Tanga (108,400, *23·5*), Pangani (98,500, *7·1*), Bagamoyo (72,800, *4·6*), Dar-es-Salaam (161,500, *15·1*), Rufiji (89,100, *10·0*), Kilwa (93,000, *1·6*) and Lindi (395,500, *8·3*). Along the frontier from the south-west to north-west are Ssongea (90,300, *1·6*), Langenburg (195,800, *6·5*), Bismarckburg (81,700, *0·9*), Ujiji (240,000, *6·2*), Urundi (1,500,000, *51·0*), and Ruanda (2,000,000, *72·0*). Along the frontier from the north-west to north-east are Bukoba (270,500, *10·0*), Muansa (620,000, *9·1*), Aruscha (84,200, *2·4*), Moschi (118,300, *9·2*), and Wilhelmstal (98,600, *6·3*). In the interior, roughly from north to south are Tabora (437,500, *4·1*), Kondoa-Irangi (218,300, *3·9*), Dodoma (299,400, *4·0*), Morogoro (158,400, *4·6*), Iringa (90,000, *1·3*) and Mahenge (120,000, *3·5*). The total native population in the Protectorate on March 31, 1913, was about 7,600,000 and the total white population 5,336, of which 4,107 were of German nationality and 90 British.

The means of communication have been improved considerably in recent years. Good roads for foot traffic exist between the sea-ports and the trading stations on the great lakes. Two railways are open for traffic. The Usambara railway from Tanga, on the coast, to Moschi, at the foot of Kilimanjaro, is complete and has a length of 219 miles. The Tanganyika or Central railway from Dar-es-Salaam to Kigoma on the lake has a total length of 777 miles. Other railways, either under construction or contemplated, are indicated on the map.

The foreign trade of the Protectorate follows either the overland or the coast routes. Of the former the most important is viâ the Victoria Nyanza ports and the Uganda railway. Another overland route is via Moschi and Taveta and the Uganda railway, but this has decreased in importance since the opening of the Usambara railway. In the south there is an outlet viâ the Shire river and by rail to Chinde, but the trade along this route is of small importance. The principal ports on the coast have already been referred to.

Climate

The temperature prevailing in German East Africa naturally varies considerably according to the altitude, proximity to the sea, etc. In the coastal plain the mean annual temperature according to Knox (*The Climate of the Continent of Africa*) varies between 77° and 82° F. At Dar-es-Salaam, for instance, it is 77·6° F., the highest and lowest temperatures recorded over a period of five years being 91·8° F. and 62·2° F. respectively. Along the coastal range the mean annual temperature is about 64·5° to 70° F., the maximum and minimum being 97° and 41° F. respectively. In the Usambara district the mean annual temperature varies from 61·3° F. at Kwai (5,280 ft.) to 73·4° F. at Mazindi (1,870 ft.), the absolute maximum in each case being 87·1° F. and 99·9° F., and the absolute minimum 41·9° F. and 56·3° F. respectively. Of stations in the interior, Ulanga, to the north-east of Nyasa, at an altitude of 754 ft., has extremes of 93·2° F. and 57·2° F., the daily variation in winter being 27° F. At Tosamaganga, near Iringa (5,578 ft.), the extremes for the year are 87·2° and 43·2° F.; the mean daily variation being 19·3° F. At Peramiho and Ngombe, in Ssongea (4,265 ft.), the mean temperature in the warmest month is 75·4° F., and that in the coolest month 61·3° F. At Tabora (4,035 ft.) the extremes are 96·9° F. and 50·7° F. At Muansa (3,723 ft.), on Victoria Nyanza, the mean maximum temperature throughout the year is 81·6° F., and the mean minimum 61·0° F.

In common with other regions in Africa near the Equator, German East Africa possesses two dry and two

rainy seasons, one in each case being longer and more thoroughly defined than the other; the chief wet season lasts from the end of February to the end of May, and the long dry season from June to October. There is a short rainy season at the end of the year, and a short dry one at the beginning. As may be expected, the broad distribution thus indicated shows exceptions in regard to different years and in different parts of the country. The year 1910 forms an example in which the long and short wet seasons both failed to bring a rainfall equal to the average; except, in the former season, in the mountainous north-east (Kilimanjaro and Usambara) and south-west (New Langenburg, especially Muaja); in the dry seasons, too, the precipitation was below the average for those times. A contrast to the conditions of 1910 is afforded by 1911, when the rainfall in the short dry season at the beginning of the year was almost as productive as the precipitation in the chief wet season of 1910 already mentioned; the long dry season of 1911, too, gave comparatively heavy rainfalls in the north-east (especially in Moschi, West Usambara, and the hinterland of Dar-es-Salaam) and the south-west (Kondeland). This statement of conditions of more than average rainfall in the mountainous districts of the north-east and south-west may cause it to be supposed that the precipitation is always large in places lying in these regions; but this is not justified in fact, for during 1912—a year when over large areas there was the greatest precipitation since measurements began to be made—both in the north-east (particularly West Kilimanjaro and Usambara) and the south-west (mainly Ssongea and the Konde Mountains), a precipitation below, sometimes considerably below, the average was experienced. Although there was this plentiful rainfall in 1912, the distribution was very unfavourable.

It is of some general interest that the meteorological observations of 1911 and 1912 give indication respectively that a quick coming in of the north-east monsoon is followed by a small precipitation in the long rainy season (March to May), and that when the monsoon comes in gradually the rainfall of the chief wet season is comparatively great.

An indication of the quantitative nature of the rainfall is

given in the following table, which presents the details of the three highest and the three lowest precipitations in 1911 and 1912:

Period.	Number of stations.	Three highest precipitations.		Three lowest precipitations.	
		Inches.	Name of station.	Inches.	Name of station.
1911	68	156·1 [1]	Muaja	16·0 [2]	Madibira
		99·0 [1]	Bukoba	16·9 [2]	Friedenstal-Pare
		96·9 [1]	Manyangu	20·0 [2]	Kondoa-Irangi
1912	70	120·6 [1]	Manyangu	21·6 [1]	Kondoa-Irangi
		98·5 [1]	Bukoba	23·6 [1]	Ngorongoro
		96·1 [1]	Shigatini	24·8 [2]	Peramiho

[1] *Higher than the average for the station.*
[2] *Lower than the average for the station.*

The information regarding earthquakes shows that the districts where these are most frequent are Usambara in the north-west and the Livingstone Mountains in the south-west. Since systematic observations have been made, the chief activity in the former district was in 1911, and in the latter in 1909; the number of days on which earthquakes were registered were 15 and 26 respectively. No damage was done.

Mineral Resources

1. *Salient Geological Features*

Topographically and geologically, German East Africa has much in common with other parts of Eastern Africa. It is bounded seaward by a low-lying coastal plain, which is occupied largely at the surface by Tertiary and Mesozoic strata and covered in places by alluvium. This coastal plain is comparatively narrow in the northern portion of the Protectorate, where it is continuous with that of the British East Africa Protectorate; but to the south of Bagamoyo it widens out considerably.

The Tertiary, Cretaceous, and Jurassic strata of the coastal plain do not appear to have hitherto yielded minerals of any considerable commercial value. They include beds of limestone, marl, and clay which will doubtless be found of value for local use in the manufacture of mortar and cement. In this connection, also, the septaria that are reported to occur at various horizons in the Jurassic clays may prove to be of value for local use; and there appears

to be an abundance of clays that can be used for brick-making.

As regards other occurrences of economic value that may possibly be found among the rocks of this coastal belt, it is perhaps worthy of note that phosphate deposits of great commercial value occur and are mined at Safâga on the Red Sea coast of Egypt, where they occur as beds in Upper Cretaceous limestone. Petroleum also occurs at certain localities in the strata of the coastal belt of East Africa; and in British East Africa beds of manganese ore occur.

The region west of the coastal plain forms part of the great central plateau highlands of Africa, which are made up largely of ancient metamorphic rocks—gneisses and schists. Cutting the gneisses and schists, however, there are extensive intrusions of granite, with which are associated pegmatites and more basic intrusions of the diorite and diabase types. It is to these various intrusions that the more important of the economic mineral deposits of the Protectorate appear to owe their origin. Gold, mica, radio-active minerals, gem minerals, and various other features of economic interest deserve exploration in this upland region of German East Africa, which is limited on the north by Victoria Nyanza, on the south by the area around the northern portion of Lake Nyasa, on the east by the coastal plain, and on the west by Lake Tanganyika.

Overlying the ancient gneisses and schists in various parts of the upland plateau, and occupying trough-fault depressions in them, are Karoo strata (Permo-Triassic), which are coal-bearing in some localities. The older rocks of the plateau highlands also underlie the Jurassic and younger strata of the coastal belt, and indeed outcrop extensively in certain portions of the coastal districts.

The difference in level between the coastal belt and the plateau highlands is regarded as due to extensive faults that run for the most part in a roughly north and south direction, and play such an important part in the tectonic features of the whole of Eastern Africa. These faults are responsible for the extensive rift depressions

or "sunk-lands" ("Graben" of German authors) which dissect the upland plateau and in certain of which the great lakes and the soda lakes occur.

Coal-bearing Karoo strata occur in the area surrounding the northern portion of Lake Nyasa. Moreover, the shales occurring in these Karoo strata are perhaps worth investigating to see if oil-shales occur amongst them.

In the Rift valley region, on and about the northern boundary of the Protectorate to the east of Victoria Nyanza, there is a considerable area occupied by volcanic rocks, including various alkali types, mostly rich in soda. Lake Natron, which is on the German side of the boundary, is one of the soda lakes that occupy portions of the Rift valley region. Like Lake Magadi, which is on the British side of the boundary, Lake Natron is rich in trona (sodium carbonate), which separates out from the waters of the lake in the form of a crystalline crust. Leucite-bearing rocks occur among the volcanic rocks of this area, and may be worth investigating as a commercial source of potash.

Volcanic rocks also cover the surface very extensively in the region to the north of Lake Nyasa.

2. *The Chief Economic Minerals*

The chief economic minerals of German East Africa are mica, gold, garnet, coal, iron ore, uranium minerals, copal, trona, and salt. All these exist in such quantity that they are either already worked or will prove worthy of consideration under suitable conditions as regards transport facilities. Mica, gold, and garnet are exported almost wholly to Germany; whilst most of the copal is exported to Zanzibar and England.

Mica.—Mica of the muscovite variety occurs in pegmatite veins that traverse gneiss in various parts of the Protectorate. An occurrence is reported in the Ssuwi stream which drains the northern slopes of the Pongwe Mountains in the Bagamoyo district. Other localities for mica are Mkondami in the Nguru Mountains, Tangiro and Mount Fissage in the Mahenge district, and the Uluguru Mountains in the Morogoro district. Still other

localities worth mentioning as showing the widespread distribution of pegmatite mica in the Protectorate are Mombo in the Usambara district, the Woto plateau in the Langenberg district, and Mawa and Muera in the Lindi hinterland.

Of these various occurrences, the most important are those at various places in the Uluguru Mountains (Morogoro district), and it is these that are chiefly mined. The predominant rock in these mountains is a biotite gneiss. The gneiss is cut by numerous veins of pegmatite, which dip vertically or at angles slightly inclined to the vertical, and which vary in thickness up to 70 ft. or so. The mica is of the muscovite variety; it is typically of a greenish or greenish-brown colour and is highly transparent in thin plates.

The chief mica-mining localities of the Uluguru Mountains are those on the Mbakana river in the southern part of the range, and those to the north of Morogoro at the northern end of the range.

On the Mbakana there is at one locality a mica-bearing zone of pegmatite some 90 ft. in length, with a maximum width of 8 ft. at the surface. At a depth of 16 ft. the width increased to over 15 ft. Mica has been found here in sheets measuring about a square yard in area; and plates, quite free from flaws, measuring up to about 1 × 1½ ft. have been obtained.

Associated with the mica in these Uluguru pegmatites are the minerals uraninite (pitchblende), rutherfordine, samarskite, galena, zinc blende, bismuthinite, copper pyrites, iron pyrites, arsenopyrite, garnet, and tourmaline.

The mica of German East Africa is highly valued for use in electrical insulation, for which purpose it is as good as ordinary Indian muscovite and Canadian amber mica, though it is substantially inferior to the best Indian ruby mica.

The total amount of mica exported from German East Africa during 1912 is given as 153,806 kilograms, valued at 481,507 marks, an increase of 55,507 kilograms and 133,221 marks as compared with the output for 1911. Except 560 kilograms which was exported to Zanzibar,

the whole of the mica exported during 1912 was sent to Germany.

Gold.—Gold occurs in the stream deposits of many parts of German East Africa, both in those flowing into the Indian Ocean and in those flowing into the Victoria Nyanza. Alluvial gold deposits have been found in the Muansa district, on the south side of the Victoria Nyanza, and on the Iramba plateau, some 160 miles south-east of Muansa.

The Iramba plateau consists chiefly of granite, but partly of schists, and these rocks are traversed by dykes and veins of diorite and pegmatite. At some localities there occur numerous quartz veins that carry gold. These gold-bearing quartz veins are usually small and variable in character. At and near the surface the deposits are fairly rich in gold, but this is due to surface enrichment, and they are found to become much impoverished at even shallow depths. Samples of gold-bearing quartz at a depth of from 10 to 20 metres were found to contain 129 oz. of gold per ton; whereas samples of the sulphide ores from a depth of from 30 to 40 metres were found to contain not more than a few pennyweights per ton.

Gold deposits closely resembling those of the Iramba plateau occur in the Ikoma goldfield, some 60 miles east of Speke Gulf (Victoria Nyanza). This area is occupied by gneiss and hornblende schists, the gneiss being predominant. The hornblende schists are traversed by gold-bearing quartz veins. Some of these veins are small, and recall the Iramba type; others are of more considerable dimensions.

Near the village of Sargidi, a short distance north of Ikoma, and near Nassa, on the south-east of Victoria Nyanza, gold-bearing quartz veins of the Iramba plateau type have been found.

At Ussongo, in the northern part of the Tabora District, a porous ferruginous breccia containing about 1 oz. of gold per ton has been observed; and at Ssamuje, to the north of Ussongo, there occur itabirites and mica schists which are traversed by gold-bearing quartz veins.

Gold has also been found in alluvial deposits near the

head-waters of the river Umbekuru, which flows into the Indian Ocean and separates the Kilwa and Lindi districts in the south of the Protectorate.

The output of gold in German East Africa during 1912 is given as 234 kilograms, valued at 531,000 marks, compared with 450 kilograms, valued at 1,023,000 marks in 1911. This gold was obtained chiefly from the Kironda mine near Sekenke, in the Iramba plateau area, where veins of gold-bearing quartz occur in association with intrusions of diorite and quartz-diorite. The output of the Kironda mine was valued at 980,000 marks in 1911 and 463,000 marks in 1912. The remainder of the output was obtained mainly from a mine in the Ngasamo district (Kassama), near Speke Gulf, on Victoria Nyanza.

The ore worked at Kironda is gold-bearing quartz. Stamp mills are in use, and the gold is presumably won chiefly by amalgamation in connection with these mills, though some of it is also obtained by cyanide treatment. The average yield of gold per ton of ore mined at the Kironda mine since 1909 has been as follows:

	Grams per ton.		*Grams per ton.*
1909. . . .	38·90	1911. . . .	45·92
1910. . . .	46·45	1912. . . .	29·29

Garnet.—Almandine garnets of value as gemstones occur in hornblende gneiss at Namaputa in the Lindi district, a little to the north of the Rovuma river, in the south-eastern portion of the Protectorate. The part of the country in which these garnetiferous gneisses occur is better known as the Luisenfelde. The hornblende gneiss is much weathered at the surface, and is consequently friable. The garnets are easily obtained from the surface rock, and they are also found loose at the surface. They are described as having a fiery columbine-red colour. They are stated to have occurred abundantly as specimens of good quality, and to have been well received on the market. Rough stones of the better class have been sold at 200 marks per kilogram. Recently, however, garnet mining seems to have been almost at a standstill. The total amount of gem garnet exported during 1912 is given as 8 kilograms, valued at 600 marks, as compared with

154 kilograms, valued at 11,811 marks, exported in 1911. The garnet was all exported to Germany.

Coal.—As already mentioned, Karoo strata occur in various parts of the plateau highlands, notably in the area surrounding the northern portion of Lake Nyasa; and these strata contain coal beds. Many of these beds are thin, and consist of coal of poor quality, as, for example, those near the mouth of the Ruhuhu on the east side of Lake Nyasa. On the other side of the lake, in the British Protectorate of Nyasaland, and opposite the Ruhuhu, are the coal-bearing Karoo beds of Mount Waller.

More important than these Ruhuhu deposits, however, are those in the Karoo beds to the north-west of the lake, on the Songwe (Songue) and Kivira rivers. In this area, a section in the Kandete stream shows a thickness of 11 metres of coal in a total thickness of 20·7 metres. One portion of this section shows a seam of coal 4·90 metres thick with two thin shale partings, which together have a thickness of only 6 centimetres.

The average composition of the coal of this 4·9 metres seam is as follows: Carbon 60·60, hydrogen 3·00, oxygen 13·00, sulphur 0·25, moisture 4·33, ash 18·50 per cent.; the yield of coke was 78·70 per cent., and the calorific value 5,657 calories. Certain of the seams show a higher percentage of carbon, up to 70 per cent., and a calorific value of 6,840 calories. The ash in some samples falls as low as 5 per cent. The coal is of the bituminous type, and is of considerable value as fuel, and on account of its coking property could be used also for smelting iron ore.

Coal is, moreover, known to occur on the western shore of Tanganyika, in the Congo territory; and as Karoo strata occur at various places on the German East Africa side of the lake, it is not improbable that coal occurs in these strata.

Iron Ore.—Iron ore of the lateritic type occurs at the surface in various parts of German East Africa, and is smelted in a primitive way by natives at Ku Ndapa in the Livingstone Mountains, north-east of Lake Nyasa.

In the Upangua district, at the southern end of the Livingstone range, and near Lake Nyasa, hæmatite ore occurs. A sample of this gave ferric oxide, Fe_2O_3, 75·75, and insoluble residue 22·88 per cent., titanium being absent. In the same region, and some miles to the south of the Ruhuhu, in the Mtambalala stream, spathic iron ore occurs, a sample of which gave ferrous oxide, FeO, 47·95; lime, CaO, 1·24; magnesia, MgO, 0·60; alumina, Al_2O_3, 1·57; carbon dioxide, CO_2, 27·04; phosphoric oxide, P_2O_5, 0·50; water, H_2O, 3·34; and insoluble residue 18·20 per cent.

More important than these perhaps are the magnetic iron ores (some of which are titaniferous, however), that occur in thick bands in the gneisses at various localities. Notable among these are the occurrences in the Uluguru range. On the western side of this range, at Hundussi, magnetite occurs, a sample of which gave magnetic iron oxide, Fe_3O_4, 65·52; titanium dioxide, TiO_2, 1·85; and insoluble residue 30·88 per cent. In the Mbakana stream titaniferous iron ore with as much as 25 per cent. of titanium dioxide occurs. Iron ore, including magnetite and hæmatite varieties, has also been found in some quantity at Midindo, near Mamboya.

Magnetic iron ore and limonite occur also in the Ruanda district and other places in the region between the Victoria Nyanza and the northern end of Lake Tanganyika, where they are to some extent worked by natives.

In connection with iron ores, the occurrence of itabirites (hæmatite schists) in the northern part of the Tabora district is perhaps worthy of note.

The existence of coking coal of good quality in the Protectorate (see p. 591) renders it desirable to explore more fully these iron ores with a view to the establishment of a smelting industry.

Cement Materials.—Crystalline limestones of metamorphic origin occur associated with the ancient gneisses in many parts of the Protectorate, as in the Uluguru, Livingstone, and Pongwe Mountains. These limestones, however, are frequently dolomitic (magnesian) and contain various secondary silicates, sometimes with apatite and graphite.

Ordinary limestones are abundant in the Tertiary,

Cretaceous, and Jurassic strata of the coastal belt. Some of these are argillaceous, and doubtless include natural cement stones.

Clays and shales also are abundant in the Tertiary, Cretaceous, and Jurassic rocks of the coastal districts. Septaria occur freely in the Jurassic clays at some horizons.

Uranium (Radio-active) Minerals.—Associated with muscovite in the pegmatites of the Uluguru Mountains (see p. 588) there are uranium minerals containing a high percentage of uranium and therefore of importance on account of their radio-active properties. The uranium minerals hitherto described include uraninite (pitchblende), rutherfordine, and samarskite, but further investigation is called for.

Uraninite (*pitchblende*).—This mineral has been found in exceptionally large crystals in the mica pegmatites of the Lukwangule hills (Mbakana area) in the Uluguru range. The uraninite is found embedded in mica in the form of cubes, octahedra, and massive lumps. A well-defined cube measuring 3·5 × 2·5 × 2 centimetres has been described, and much larger specimens showing crystalline form are found.

Masses of uraninite weighing as much as 70 lb. are stated to have been found as isolated aggregates in the pegmatite veins. The unaltered uraninite has a specific gravity about 8·8, and one specimen with a specific gravity 8·63 gave the following analysis: uranium oxide, U_3O_8, 89·47; lead oxide, PbO, 6·87; lime, CaO, 0·82; silica, SiO_2, 0·52; ferrous oxide, FeO, 0·48; thoria, ThO_2, 0·20; water, H_2O, 2·03 per cent. The uraninite specimens are frequently altered on the surface to rutherfordine, and some are completely pseudomorphosed.

It is of interest to note that the occurrence of uraninite in these mica pegmatites of German East Africa is closely paralleled by the occurrence of uraninite in the mica mines near Singar in the Gaya district of Bengal.

Rutherfordine.—This is a yellow uranium carbonate (UO_2CO_3) formed as an alteration product of the Uluguru uraninite, specimens of which are usually covered by a

yellow crust of this material. Some specimens are completely altered (pseudomorphosed) to this yellow carbonate, which has a specific gravity of 4·82. An analysis of a specimen of rutherfordine gave uranium oxide, UO_3, 83·8; carbon dioxide, CO_2, 12·1; lead oxide, PbO, 1·0; ferrous oxide, FeO, 0·8; lime, CaO, 1·1; water, H_2O, 0·7; insoluble residue, 0·8 per cent.

Samarskite.—Specimens of samarskite containing 7·5 per cent. of lead oxide, and for this reason described as a separate species under the name "plumboniobite," have been found in the mica pegmatites of the Morogoro district, in the mica mines at the northern end of the Uluguru range. A specimen with a specific gravity 4·8 gave the following analysis: niobic oxide, Nb_2O_5, 46·03; tantalic oxide, Ta_2O_5, 1·20; uranium oxide, UO_2, 13·60; titanium dioxide, TiO_2, 0·90; yttria, Y_2O_3, 14·12; ferric oxide, Fe_2O_3, 5·72; alumina, Al_2O_3, 0·17; lead oxide, PbO, 7·55; copper oxide, CuO, 1·21. The percentage of lead is higher than that usually recorded for samarskite, but is insufficient to warrant one in regarding this as a new species; it is therefore described here as a samarskite. It is worthy of note that samarskite occurs in certain mica pegmatites of Canada and India under conditions closely similar to those obtaining in the Morogoro mines of German East Africa.

Copal.—At many localities on the coastal plain and near the coast, as on the Noto, Makonde, and Muera plateaux, fossil resin of the copal variety is dug from the surface sands by natives. The pits from which it is obtained are very shallow, being dug to a depth of not more than 2 ft. The winning of copal in this way is sufficient to repay the labour of the natives, who send the copal to Lindi and other markets on the coast. The product comes on the British market via Zanzibar and is known here as Zanzibar copal.

There has been a gradual decrease in the exports of copal in recent years, except in 1912, when there was a small increase to 106 tons, worth nearly £6,000. Partly owing to the extent to which the copal-bearing alluvium has been already worked, and partly owing to the fact that there are other and more remunera-

tive fields of labour for the natives, it is not expected that this increase will be maintained.

Trona (hydrated acid sodium carbonate) occurs abundantly in the form of a white crystalline crust in Lake Natron, a large soda lake occupying a portion of the Rift valley near the northern boundary of the Protectorate, between Victoria Nyanza and Kilimanjaro. The trona deposit of Lake Natron is of the same character as that of Lake Magadi in British East Africa, which is at the present time the object of a great commercial enterprise. A sample of trona from the south-west shore of Lake Natron gave on analysis 68·5 per cent. of sodium carbonate (Na_2CO_3), and 29·5 per cent. of water (H_2O).

Salt.—The natives obtain common salt in a very primitive manner by the evaporation of sea water in shallow "salines" along the coast. More important is the Gottorp Saline in the Ujiji district near Tanganyika, from which there was during 1912 an output of 2,000 tons of salt, valued at 200,000 marks. This salt is obtained from the water of salt springs by evaporation. The spring water is of a dirty yellow colour; it smells strongly of sulphuretted hydrogen, has a specific gravity of about 1·1, and contains about 11·6 per cent. of sodium chloride.

3. *Other Minerals of Economic Interest*

Under this heading may be enumerated the various minerals of economic interest which have hitherto been found in only small quantities, usually too small to make them worth working. These may, however, be regarded as of some importance from the prospector's standpoint, since their occurrence would suggest the possibility that larger deposits may occur.

Agate (a banded variety of compact silica) is stated to occur associated with amethyst, near Gottorp in the Ujiji district.

Amethyst (a gemstone variety of quartz).—Transparent amethyst of a fairly good colour has been found at Midindo, a locality between Mamboya and Kitangi, in the eastern portion of the Dodoma District.

Amethysts are also stated to occur associated with agates near Gottorp, in the Ujiji district.

Arsenopyrite (sulphide of iron and arsenic) occurs in the auriferous quartz veins of the Ikoma district, and in the mica pegmatites of the Uluguru Mountains.

Asbestos is reported to occur at Morogoro, and the occurrence is said to be a promising one.

Beryl (silicate of beryllium and aluminium) of a pale green colour occurs associated with tourmaline and muscovite in pegmatite veins traversing gneiss at Namaputa, near the garnet locality mentioned on p. 590.

Bismuthinite (sulphide of bismuth) occurs in the mica pegmatites of the Uluguru Mountains.

Bitumen.—An occurrence of material described as bitumen has been observed at Wingayongo. It gave on analysis: carbon 20·29, hydrogen 1·75, oxygen 0·99, nitrogen 1·02, sulphur 1·89, water 1·85, and ash 72·21 per cent. The high percentage of carbon and the low percentage of hydrogen in the ash-free portion of this material would appear to indicate that it is more in the nature of coaly material than true bitumen; and the occurrence is not such as can be regarded as an indication of the presence of petroleum.

Bitumen is also reported to occur in the area at the north end of Lake Tanganyika.

Copper Pyrites (sulphide of copper and iron) occurs in the auriferous quartz veins of the Ikoma district, and associated with muscovite in the pegmatites of the eastern part of the Uluguru Mountains.

Ore-minerals of copper are stated to occur also at Massassi in the Lindi hinterland, and in the Langenburg district near the north end of Lake Nyasa, but no considerable deposit of copper ore has yet been found.

Corundum.—Crystals of reddish opaque corundum, 2 to 3 cm. in length, have been found at Mulale (Mlale), a locality in the eastern part of the Dodoma district. Associated with this corundum, and embedded in it, were small crystals of rutile.

Diamond.—A fine crystal of diamond was discovered in the coastal sands at Bagamoyo in 1911; but though this

occurrence appears to have been fully confirmed, it has not been followed by any further discoveries.

Epsomite (hydrated sulphate of magnesium) occurs in the Karoo shales outcropping in the Kokwa Mdogo stream, a tributary of the Rufiya river.

Felspar.—The orthoclase variety of felspar (silicate of potassium and aluminium) occurs abundantly in the mica-bearing pegmatites of the gneissic areas.

Galena (lead sulphide) occurs in the auriferous quartz veins of the Ikoma district and in the mica pegmatites of the Uluguru Mountains. Lead ores are stated to occur at Kondoa Irangi, but hitherto no workable deposits have been found.

Garnet of the almandine gemstone variety (silicate of iron and aluminium) has already been referred to as occurring at Namaputa. In addition to this it occurs abundantly in other gneissic areas, as in the Usambara district and the Uluguru mountains, in the coarser variety that is sometimes used for abrasive purposes.

Graphite (a crystalline variety of carbon) occurs in some abundance disseminated through gneiss in various parts of the Protectorate, notably in the central and eastern parts of the Uluguru Mountains, and in the Lindi hinterland. These graphitic gneisses are abundant in other parts of east-central Africa, and in certain places, as in Nyasaland, there occur lenticular masses of exceptionally good quality, though of limited extent. Lenticular masses of graphite occur in the gneisses of the Lindi hinterland, but no deposits that are workable under existing conditions have yet been found in German East Africa.

Gypsum (hydrated calcium sulphate) occurs in the Jurassic strata of the coastal plain. It is seen in outcrops in the Mahakonde stream in the Kilwa district, and it occurs also further north in Ukhwere.

Iron Pyrites (iron disulphide) occurs in the gold-bearing quartz veins of the Ikoma district; also in the mica pegmatites of the Uluguru Mountains, and at various other localities. Cupriferous pyrites occurs in quartz veins near Ubena, in the southern part of the Iringa district.

Kaolin (hydrated silicate of aluminium).—Pure white china clay, resulting from the alteration of orthoclase felspar, has been found at Ikwamba, between Uponera and Kisitwi in the eastern portion of the Dodoma district. Kaolin occurs also in the Karagwe district not far from Buboba, to the west of Victoria Nyanza.

Leucite (silicate of potassium and aluminium).—This mineral, which has been used elsewhere to some extent as a source of potash salts, occurs as a constituent of certain of the alkali volcanic rocks in the northern portion of the Protectorate, notably around Niragongo in the area to the north-east of Lake Kivu, Ruanda district.

Lignite or Brown Coal occurs in clay beds that outcrop in the Makebe stream in the hinterland of Mtshinga. An analysis of this brown coal gave carbon 54·70, hydrogen 3·05, oxygen 21·78, sulphur 0·01, moisture 16·26, and ash 4·20 per cent. The yield of coke was 46·15 per cent., and the calorific value 5,030 calories. The lignite seen in the Makebe stream does not form continuous beds, but occurs in the form of isolated lumps and broken layers. Associated with the brown coal in these Makebe clay beds are lumps of yellow ochre and earthy sulphur which appear to have resulted from the decomposition of pyrites.

Manganese Ore occurs in the Unata district some 25 kilometres W.N.W. of Ikoma; and psilomelane has been found in the Kipengele hills, in Livingstone Mountains.

Monazite (phosphate of cerium and other rare earths, with a variable percentage of thoria).—This mineral is known to occur in other parts of East Africa, and it is probable that it occurs also in German East Africa (see tin ore, p. 599).

Phenacite (beryllium silicate).—A crystal of perfectly colourless and transparent phenacite of gem quality, 1½ cm. long and nearly 1 cm. wide, has been found in the Kisitwi Mountains, which lie to the east of Mpapua (Mpapwa) in the eastern portion of the Dodoma district. The rocks of these mountains consist of biotite gneiss and garnetiferous hornblende gneiss, which gneisses are not improbably traversed by pegmatite veins.

Silver Ore is said to occur near Ujiji on the east side

of Tanganyika; and also in the area west of Victoria Nyanza, near the northern boundary of the Protectorate.

Sulphur.—The sandstones of Wingayongo are impregnated with sulphur, crystals of which occur in the cavities of the rock. The amount of sulphur present in the sandstone is stated to be too low to make the rock workable as a source of sulphur.

Tin Ore.—No tin ore has been found up to the present, but it has been suggested that both tinstone and monazite may be expected to occur in association with the granitic intrusions which have such an extensive distribution on the upland plateau.

Tourmaline (a complex boro-silicate of aluminium, iron, magnesium, and other elements) occurs in the pegmatites of Namaputa near the garnet locality, and in the mica pegmatites of the Uluguru Mountains. It occurs also in good crystals in the Kisitwi mountains, and doubtless in many other localities, but the specimens hitherto found have been of the black variety, opaque in the mass, and of no value as a gemstone.

Zinc Blende (zinc sulphide) occurs in the mica pegmatites of the Uluguru Mountains.

From this brief account of our knowledge of the minerals of German East Africa and of the geological conditions under which they occur, it is evident that the country is highly mineralised, and that its further commercial development from this point of view only awaits more detailed systematic prospecting such as has been carried on under the auspices of the Imperial Institute in other countries.

In a succeeding article the Agricultural and Forest Resources of German East Africa will be described.

THE PRESENT SCARCITY OF THE ANTISEPTIC THYMOL

HITHERTO almost the sole source of commercial thymol has been ajowan oil derived from ajowan seeds (*Carum copticum*, Benth.). Prior to the war practically the whole

of the exports of ajowan seeds from India went to Germany, where the thymol was prepared. Owing to the cessation of trade between this country and Germany there has been a great scarcity of thymol in the United Kingdom, and the price has increased greatly. Up to the end of July the price had risen considerably owing to a deficiency in the supply of ajowan seed, and since then it has reached as much as 40*s.* per lb. The fluctuation in price since April last is shown in the following table:

	Per lb.		*Per lb.*
April 16	6*s.* 8*d.*–6*s.* 9*d.*	August 20	25*s.*
May 21	6*s.* 6*d.*–6*s.* 9*d.*	September 3	30*s.*
June 4	7*s.* 6*d.*	September 17	40*s.*
July 2	7*s.* 9*d.*	October 1	25*s.*–30*s.*
July 16	9*s.*–9*s.* 3*d.*	November 5	25*s.*
July 30	14*s.*–14*s.* 6*d.*	December 21	21*s.* 6*d.*

The manufacture of thymol is a simple process, and there is no reason why it should not be carried on in this country. At the same time the possibility of obtaining thymol from other sources is worth consideration, as well as the possibility of employing the isomeric phenol, carvacrol, in place of thymol for antiseptic purposes.

Preparation of Thymol

The distillation of the volatile oil from ajowan seed can be readily carried out by the ordinary method in which the seeds, previously crushed or comminuted, are placed in a wire basket or on a false bottom in a still in which steam is either generated or received from a separate boiler. The quantity of oil in the seed is about 3 to 4 per cent., and the oil usually contains from 40 to 55 per cent. of thymol.

For the preparation of thymol the oil should be freshly distilled, pale coloured and clean. It is shaken thoroughly with a warm aqueous solution of caustic soda, which dissolves out the thymol, the latter remaining in the aqueous layer when this separates from the residue of the oil. The aqueous layer is collected by means of any ordinary form of separator, or separating funnel, and the treatment repeated on the residual oil until the latter is free from

thymol. The combined warm aqueous liquids are then set aside to clear completely, and when quite clear they are acidified by the addition of excess of hydrochloric acid, when the thymol rises to the surface as an oily layer. The acid aqueous liquid is run off and replaced by clean warm water, which is shaken up thoroughly with the thymol to remove all traces of acid. The washing water is then run off completely, and the warm liquid thymol run into a dish and a crystal of thymol added. The mass then usually solidifies, and merely requires pressing free from liquid to yield crystalline thymol.

The residual oil, which amounts to about 50 per cent. of the original oil, allowing for loss in manufacture, is generally sold as a cheap perfume for soap-making and similar purposes under the name "thymene."

New Sources of Thymol

In addition to ajowan seeds there are a number of plants which yield oils containing thymol, the more important of which are dealt with below.

Cunila mariana, L.—This plant, which yields oil of dittany, is native to North America. The dry herb yields 0·7 per cent. of oil containing about 40 per cent. of a phenol which has been stated to consist of thymol.

Monarda punctata, L. (American horsemint).—This yields from 1 to 3 per cent. of oil containing 61 per cent. of thymol. According to *Schimmel & Co.'s Report* (Oct. 1885, p. 20), the oil at one time was used for the preparation of thymol on a large scale.

Mosla japonica, Maxim.—The dry herb of this plant, which is indigenous to Japan, yields 2·13 per cent. of oil containing 44 per cent. of thymol.

Ocimum gratissimum, L.—This West African plant yields an oil which is stated to contain 44 per cent. of phenolic constituents, consisting almost entirely of thymol (cf. this BULLETIN, 1913, **11**, 131).

Ocimum viride, Willd.—Several samples of this plant, which is known in West Africa and the West Indies as the "mosquito plant," owing to its alleged property of keeping off

these insects, have been examined at the Imperial Institute. A sample of the dried leaves from the Northern Provinces of Nigeria yielded 1·2 per cent. of oil, while three samples from Sierra Leone yielded 0·35, 0·86, and 0·89 per cent. of oil respectively. The oil in the latter cases was found to contain 32, 55, and 65 per cent. of thymol. A sample of the oil distilled in Sierra Leone has also been examined, and this was found to yield 58 per cent. of thymol.

Origanum floribundum, Munb.—Native to North Africa, and yields an oil containing about 25 per cent. of thymol.

Origanum hirtum, Link.—Specimens of this plant collected in Dalmatia have been examined at the Imperial Institute. The dry herb yielded 3·3 per cent. of oil containing 66–67 per cent. of thymol (this BULLETIN, 1911, 9, 388). Oils distilled from plants grown in the Adriatic islands of Curzola and Lissa have been stated to yield 51 to 60 per cent. of thymol.

Satureia Thymbra, L.—According to *Schimmel & Co.'s Report* for October 1889, p. 55, this plant yields an oil containing about 19 per cent. of thymol.

Thymus vulgaris, L.—The phenol content of thyme oil varies as a rule from 20 to 25 per cent., but in rare cases rises to 42 per cent. The character of the phenol varies; as a rule in French and German oils it consists mainly of thymol, but under certain conditions the latter may be replaced by carvacrol. The yield of oil from the dried German herb is 1·7 per cent. and from the dried French herb 2·5 to 2·6 per cent.

Of the plants referred to above, *Ocimum viride*, *Monarda punctata*, *Origanum hirtum*, and *Thymus vulgaris* appear to be the most promising as sources of thymol. *Ocimum viride* is stated to occur wild on all soils in every part of Sierra Leone, and a few plants are cultivated in nearly every yard in the Colony on account of its medicinal properties. The plant also occurs in other parts of West Africa and in the West Indies. It can be easily raised rom seed, and its cultivation might prove profitable under present conditions. *Monarda punctata* occurs in parts of Canada and the United States, and it should be possible to obtain supplies of the herb. *Origanum hirtum*, on the

other hand, occurs in the Eastern Mediterranean region, and in view of the disturbed state of that area it is doubtful whether the plant could be collected in sufficient quantities at the present time.

Thyme oil, from *Thymus vulgaris*, is of course an article of commerce, and judging from the price of the French oil on the market there is so far no scarcity in the supplies; the price in London on October 20 was the same as that on January 19, viz. 5*s.* per lb. With thymol at its present high price it would pay to prepare it from thyme oil, but not under normal conditions.

Carvacrol as a Substitute for Thymol

Carvacrol is a phenol isomeric with thymol, and this fact alone suggests that it might be of value for antiseptic purposes. When freshly distilled, carvacrol is a colourless, viscid oil which becomes yellowish in the course of time. It has melting point + 0·5° to + 1° C., boiling point 236° to 237° C. (corrected), and specific gravity at 15° C. 0·981. Carvacrol is the chief constituent of the oils derived from a number of plants belonging to the N.O. Labiatæ, the most important being the following:

Monarda fistulosa, L. (wild bergamot).—This oil contains 52 to 58 per cent. of carvacrol.

Origanum dubium, Boiss. (Cyprus origanum).—This oil has been investigated at the Imperial Institute and found to contain 82·5 per cent. (by volume) of carvacrol (this BULLETIN, 1906, **4**, 296; 1908, **6**, 208). Trieste or Cretan origanum oil also consists principally of carvacrol, but the botanical origin of the plant yielding this oil seems to be doubtful. It is sometimes said to be *O. hirtum*, Link, but a sample of the latter herb, examined at the Imperial Institute, contained thymol, not carvacrol (see p. 602).

Origanum Onites, L. (= *O. Smyrnaeum*, L.).—This plant yields Smyrna origanum oil. A specimen of the herb has been examined at the Imperial Institute and yielded an oil containing 68 per cent. (by volume) of phenols, consisting almost wholly of carvacrol (this BULLETIN, 1911, **9**, 388).

Satureia hortensis, L.—The oil contains 38 to 42 per cent. of carvacrol.

Satureia montana, L. (white thyme).—The oil distilled from wild plants of this species contains 35 to 40 per cent. of carvacrol, but that from cultivated plants has been found to contain as much as 65 per cent. A sample of Dalmatian white thyme, identified at the Royal Botanic Gardens, Kew, as a form of *S. montana*, L., has been examined at the Imperial Institute. It yielded an oil containing 68·75 per cent. of phenolic constituents consisting mostly of carvacrol (*loc. cit.*).

Thymus vulgaris, L. (thyme).—As already mentioned thyme oil sometimes contains carvacrol in place of thymol (see p. 602).

Of these oils Cyprus origanum oil is the most promising as a source of carvacrol at the present time; most of the others not only contain less but are produced in regions which are greatly affected by the war. The Cyprus oil is already produced in commercial quantities, 42 cwts., valued at £980, being exported to the United Kingdom in 1913. So far the oil has been obtained solely from wild plants. It has been suggested, however, that the plant could probably be cultivated profitably, and it has been stated that experiments to determine this point were to be carried out by the Agricultural Department in 1913, but the results have so far not been published.

The chief use for thymol is the preparation of various antiseptic toilet preparations, but it has also been employed in recent years in the treatment of ankylostomiasis, certain skin diseases, etc. So far as can be ascertained, carvacrol has not hitherto been employed in medicine, but the antiseptic properties of origanum oil, consisting principally of carvacrol, as well as of the phenol itself, have been investigated by several workers. Chamberland (*Ann. de l'Inst. Pasteur*, 1887, **1**, 153), in a series of experiments with various essential oils, showed that a saponaceous solution of origanum oil containing 1 part of oil in 24,200 parts of solution inhibited the growth of the anthrax bacillus, and that the oil had practically the same antiseptic power as copper sulphate. Experiments carried out by

Cadeac and Meunier (*loc. cit.* 1889) also demonstrated the powerful bactericidal action of origanum oil.

The value of carvacrol as an antiseptic has been investigated by Dr. W. Harrison Martindale (*Perf. and Ess. Oil Record*, 1910, **1**, 266), who found that in its action on *Bacillus coli communis* it had a carbolic acid coefficient of 21·32 as compared with 25·29 in the case of thymol, whilst origanum oil, containing 82 per cent. of carvacrol, had a coefficient of 25·76. This means that by the test employed origanum oil and carvacrol were 25·76 and 21·32 times, respectively, as strong an antiseptic as pure carbolic acid. As an outcome of Dr. Martindale's experiments saponaceous solutions of origanum and other oils have been prepared for physicians' use under the name "Perfumed Formosyls." Iodide of carvacrol ("iodocrol"), a reddish-brown powder, has been used as an antiseptic. It is said to possess the advantage over iodoform of being odourless and 5 times the strength in bactericidal power, whilst it is more bulky and therefore of greater value for dusting purposes. Iodocrol has also been used in surgical dressings in the treatment of eczema, chancre, and other diseases.

GENERAL NOTES

Report on the Work of the Imperial Institute, 1913.—A summary of the work carried out at the Imperial Institute for the Dominions, Colonies, and Dependencies during 1913 has now been issued in the *Annual Series of Colonial Reports*, No. 816 [Cd. 7622-7].

Mineral Survey of the Southern Provinces, Nigeria.—The Report on the results of the work conducted in connection with the Imperial Institute by the Mineral Survey of the Southern Provinces, Nigeria, during 1913 has recently been published in the *Miscellaneous Series of Colonial Reports*, No. 89 [Cd. 7567]. In that year the work of the Survey was devoted to exploring the western boundary of the Udi-Okwoga coalfield and to ascertaining the shortest distance of a workable seam from Onitsha or Idah. Several boreholes were put down near Onitsha, and seams of coal were met with at two places. Surface prospecting was also carried on, and coal seams were found in the Idah district and in the west of the Udi coal

district. The western boundary of the coalfield was defined, and it was found that the coal measures gradually increased in width from about 10 miles in the extreme south to about 40 miles in the north.

The Report also includes the results of examination at the Imperial Institute of mineral specimens collected by the surveyors during the year. Several samples of coal were examined, as well as samples of lignite, clay, iron ore, and limestone, and specimens of rocks and other material from various boreholes.

Proceedings of the Third International Congress of Tropical Agriculture.—Reference has already been made in this BULLETIN to the Third International Congress of Tropical Agriculture, which was held at the Imperial Institute in June 1914. The *Proceedings* of the Congress have now been published by Messrs. John Bale, Sons & Danielsson, Great Titchfield Street, Oxford Street, London, W., and copies can be obtained from booksellers or from the publishers at 10s., or 10s. 4*d*. post free in the United Kingdom, abroad, 10s. 8*d*.

The *Proceedings* occupy 407 octavo pages, and contain the address delivered by the President of the Congress, Professor Wyndham Dunstan, C.M.G., LL.D., F.R.S., Director of the Imperial Institute and President of the International Association for Tropical Agriculture. Abstracts of all the more important papers read at the Congress are also printed, as well as a full report of the various important discussions which took place.

The subjects discussed at the Congress included: Technical Education in Tropical Agriculture; Sanitation and Hygiene on Tropical Estates; Legislation against Plant Diseases and Pests; Agricultural Credit Banks and Co-operative Societies; The Organisation of Agricultural Departments in relation to Research; The Fertility of Soils; The Properties of Plantation Para Rubber, with Special Reference to its Uses for Manufacturing Purposes; and The Improvement of Cotton Cultivation. In addition papers were read and discussed on rubber, cereals, sugar, cocoa, tobacco, jute and hemp fibres, cotton, and other tropical products.

Among the speakers in these discussions were the Right Hon. Lewis Harcourt, M.P., Secretary of State for the Colonies, Earl Kitchener, Earl of Derby, Lord Emmott, and well-known authorities on tropical agricultural from all parts of the world. The volume is a valuable record of authoritative opinions on the important problems of tropical agriculture and industries, which are of special interest at the present time.

Barosma venusta leaves from South Africa.—A sample of *B. venusta* leaves from South Africa was received at the

Imperial Institute for examination in February 1912. It was desired to ascertain whether the leaves could be used in medicine as a substitute for buchu leaves of commerce derived from *B. betulina*. On distillation in a current of steam the leaves yielded 2·7 per cent. of a volatile oil, which was of a lemon-yellow colour and pleasant odour, with specific gravity at 15°/15° C. 0·877, and optical rotation in a 100 mm. tube at 24° C. + 1° 4′. A larger consignment of the leaves, received in 1913, furnished 2 per cent. of volatile oil with the following constants: specific gravity at 15°/15° C. 0·865, optical rotation in a 100 mm. tube at 22° C. + 0° 47′, acid value 5·6, ester value 6·2 (corresponding with 2·2 per cent. of esters, calculated as $C_{10}H_{17}\cdot OAc$), ester value after acetylation 55 (corresponding with 15·7 per cent. of total alcohols, or 14·3 per cent. of free alcohols and 2·2 per cent. of esters).

A detailed chemical examination of this oil has been made by Dr. Ernest Goulding, F.I.C., and Mr. O. D. Roberts, A.I.C., of the Scientific and Technical Department of the Imperial Institute, and the results communicated recently to the Chemical Society of London (*Journ. Chem. Soc.*, 1914, **105**, 2613). The approximate percentage composition of the oil was found to be as follows: hydrocarbons, chiefly or entirely myrcene, 43·0; aldehydes, chiefly or entirely anisaldehyde, 0·5; phenols, 0·2; phenol ethers, methylchavicol, 21·4; alcohols, partly linalool (calculated as $C_{10}H_{17}\cdot OH$), 14·3; esters (calculated as $C_{10}H_{17}\cdot OAc$), 2·2; sesquiterpenes, loss, etc. (by difference), 18·4. Diosphenol, the most characteristic constituent of the oil of *B. betulina*, was shown to be absent.

The oil of *B. venusta* thus differs considerably from that of *B. betulina*, and the leaves of the former species cannot be used in medicine in place of the ordinary buchus of commerce.

Estimation of Prussic Acid in Feeding-Stuffs.—The value of a feeding-stuff depends not merely on the amount of nutritive material present, but also on the presence or absence of harmful ingredients. Of the latter, cyanogenetic glucosides, which on hydrolysis give rise to the formation of hydrocyanic acid (prussic acid), are of frequent occurrence (see this BULLETIN, 1903, **1**, 15, 112; 1905, **3**, 373; 1906, **4**, 334; 1912, **10**, 653). The estimation of hydrocyanic acid by the iodine or silver nitrate titration methods often presents some difficulty, especially when oils or fats are present, and a new method has been devised by Dr. J. R. Furlong, Ph.D., of the Scientific and Technical Department of the Imperial Institute (*Analyst*, 1914, **39**, 430). The method consists essentially in the conversion of the hydrocyanic acid into prussian blue and the comparison of the resulting coloration with standards. Full details regarding the method of preparing the material and the standards are given.

The paper also quotes the results of examination at the Imperial Institute of millet and guinea corn plants from the Northern Provinces, Nigeria, which have been shown to contain cyanogenetic glucosides under certain conditions (cf. this BULLETIN, 1910, **8**, 384).

The Viscosity of Rubber Solutions.—The question of the viscosity of rubber solutions is one of considerable importance in view of the suggestion that the viscosity is closely connected with the quality and technical value of the rubber. The viscosity of solutions of plantation Para, fine hard Para, Castilloa, Funtumia, and Ceara rubbers has been investigated recently in the Scientific and Technical Department of the Imperial Institute by Dr. R. Gaunt, Ph.D., and a paper giving details of the results was lately read before the Society of Chemical Industry (*Journ. Soc. Chem. Indust.*, 1914, **33**, 446). The paper deals with the solubility of rubber, viscosity of rubber in different solvents, change in viscosity of rubber solutions, the effect of concentration on the change in viscosity, change in viscosity of rubber in different solvents, and the change in viscosity of different rubbers in solution.

New Markets for Sudan Produce.—Owing to the war and the consequent cessation of trade with Germany and Austria-Hungary, a quantity of material formerly exported to those countries from the Sudan has become available for other markets. Foremost among such products is gum arabic, the total exports of which amounted to 15,129,200 kilograms, valued at £381,203, in 1913. Of this quantity 2,843,784 kilograms, of value £68,821, went to Germany direct, and 610,763 kilograms, of value £14,048, to Austria-Hungary. Among other countries to which the gum was exported were France (3,505,757 kilograms, valued at £90,618), United Kingdom (2,720,961 kilograms, valued at £70,092), and United States (2,068,820 kilograms, valued at £52,088). An account of the uses and value of Sudan gum will be found in this BULLETIN (1908, **6**, 29).

Other products available for export are sesame seed, dura, vegetable ivory nuts, sant pods, hides and skins, and ivory.

Most of the sesame hitherto exported from the Sudan has gone to Egypt, but 249,589 kilograms, valued at £3,926, went to Germany in 1913. The total exports in that year amounted to 6,841,260 kilograms, valued at £107,673. Two samples of the seed from the Sudan were examined at the Imperial Institute in 1912; they were both of good quality, and the better was valued at £17 10*s.* per ton, with large white Bombay seed at £17 17*s.* 6*d.* per ton (this BULLETIN, 1913, **11**, 56).

Dura (*Sorghum vulgare*) is the staple food grain of the country, and only the surplus produce is available for

export. The amount exported in 1913 was 2,080,071 kilograms, valued at £22,282, all of which went to Egypt and Eritrea. This year the rains have been very favourable, and it is anticipated that a considerable quantity of the grain will be available for export. Feeding trials with Sudan dura have been carried out in Austria and in this country which have shown that it is about equal in value to maize for this purpose (this BULLETIN, 1911, **9**, 253; 1913, **11**, 37), whilst technical trials have indicated that it could probably be substituted for maize in the manufacture of certain kinds of spirit.

The vegetable ivory nuts exported from the Sudan are derived from the dom or doum palm (*Hyphaene thebaica*). They are already exported to some extent to this country, but the chief markets are Italy and the United States. The total exports in 1913 amounted to 1,349,109 kilograms, valued at £8,190. For an account of the utilisation of these nuts as vegetable ivory, see this BULLETIN (1911, **9**, 105).

Sant pods, derived from *Acacia arabica*, are widely used in the Sudan for tanning purposes. The whole pods contain about 30 per cent. of tannin, and yield a leather of good quality and pale colour. A sample of the whole pods examined at the Imperial Institute recently was valued at £7 per ton, and a small experimental consignment was subsequently sold at this price (this BULLETIN, 1913, **11**, 408).

The total value of untanned hides exported from the Sudan in 1913 amounted to £23,415, of which more than half went to Austria and France in about equal proportions. Untanned skins of sheep and goats to the value of £32,737 were also exported in 1913, chiefly to the United Kingdom, Egypt, and France.

Large numbers of cattle and sheep are available for export to Egypt and the nearer markets in the Mediterranean region, and on the Red Sea. The total value of cattle, sheep, and goats exported in 1913 amounted to £176,195.

Further information in regard to the above products and means of securing supplies may be obtained on written application to the Director of the Imperial Institute, South Kensington, S.W., and specimens of most of them may be seen in the Sudan Court of the Public Exhibition Galleries of the Imperial Institute.

Indian Mowra Seed.—Owing to the closing of German and Austrian markets consequent on the war, there are a number of Indian products, hitherto purchased in large quantities by those countries, for which Indian exporters are seeking new outlets. Amongst these is Indian mowra or mowa seed, which has so far received little if any attention from British oil-seed crushers. For several years Germany has been the chief purchaser of India's exports

of this product, and last year (1913–14) over 85 per cent. of the mowra seed shipped from India went to Germany.

The following table shows the total exports of mowra seed from India, and the quantity and value taken by Germany:

	Average for three years ending 1911-12.		1912-13.		1913-14.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	cwts.	£	*cwts.*	£	*cwts.*	£
Exports to Germany	407,228	185,710	187,054	100,020	567,670	309,791
Total exports . .	664,942	303,709	265,861	142,913	665,979	364,000

Mowa or mowra seeds are the product of species of Bassia which occur throughout the East Indies, and yield fats suitable for edible purposes. In India the fat is expressed from the kernels of the seeds and is eaten. An account of the investigation of samples of Bassia kernels and fats from India and Ceylon has already been given in this BULLETIN (1911, **9**, 228). Probably an important reason why mowra seeds have been disregarded by British oil-seed crushers is that the cake is not suitable for feeding to stock, and can only be used as manure. In view of the possibility of supplies of these seeds, which would in normal times have gone to Germany, becoming available at advantageous prices, the question of their utilisation is worthy of the attention of British oil-seed crushers and makers of edible fats.

Seed Control Stations on the Continent.—As the seed purchased by the farmer varies much in quality, and its value cannot be determined by mere inspection, it is a matter of considerable importance that he should be protected by being able to have his seed examined at a moderate fee, and this procedure has a good effect in raising generally the quality of the seed supplied by vendors. On the Continent this is carried out at seed control stations. Nine of these stations, namely those at Copenhagen, Hamburg, Wageningen in Holland, Zurich, Budapest, Vienna, Munich, Breslau, and Berlin have been visited by Mr. H. C. Long, an officer of the Board of Agriculture, and an account of the work they do forms *Supplement* No. 13 of the August number of the *Journal of the Board of Agriculture*. The first six are Government institutions, and the two next receive State grants.

The examination of the seeds is directed to their identity, place of origin, purity, germinating capacity, germinating energy, weight of 1,000 seeds, weight of a litre of the seed, and percentage of moisture. In examining the purity the points attended to are the proportions of (1) pure seed, (2) sand, dirt, chaff, waste material, etc., (3) seeds of other cultivated plants, and (4) weed seeds. A good deal of attention is given to the search for dodder. The germinating capacity is determined by treating the

seeds in various ways and for periods of time suited to their nature, and ascertaining what proportion have germinated. The proportion that have germinated at the end of about one-third of the period allowed is taken to represent the germinating energy. In stating the germinating capacity an allowance is made for "hard seeds." Various formulæ are used to give an estimate of the value of the sample. The above outline, however, does not apply uniformly to all the stations, as the methods of examination and plans of reporting naturally vary.

In the United Kingdom the examination of seeds is carried out by many different bodies. In England by the Botanist of the Royal Agricultural Society; in Scotland by the Botanist of the Highland and Agricultural Society; and in both countries at numerous colleges and laboratories, a list of which is given in the *Trans. Highland and Agric. Soc. of Scotland* (1913, **25**, 102). In Ireland there is a Seed Testing Station conducted by the Department of Agriculture and Technical Instruction, and quite recently one has been started under the Board of Agriculture, for Scotland.

Cotton Pests in German East Africa.—An account of about seventy actual or possible enemies of the cotton plant in German East Africa, mostly insects, is given in *Beiheft* No. 1, of *Der Pflanzer*, 1914, vol. **10**. Among these the following are some of the most serious.

The leaf beetle, *Syagrus puncticollis*, is about 6 to 8 millimetres long and attacks the stems of quite young plants, and also the leaf stalks and the leaves. The leaves are found pierced with holes and hanging limp and the beetles can be found in pairs in the folds. It has been observed that the beetle appeared at the commencement of the main rainy season, and the attack was most severe where the cotton followed high grass, and was scarcely noticeable where it followed maize. The insects can be shaken off into a vessel of water and petroleum, or spraying with a solution containing 1 per 1,000 of sodium arsenite may be adopted.

The small black cotton weevil, *Apion xanthostylum*, is a dangerous pest; it is 2 to 3 millimetres long and dull black in colour with white hairs which give it a grey appearance. The larvæ inhabit the base of the unripe capsules and also establish themselves in the bark and in the wood of the root top, the stem, and the twigs, and injure the growth of the whole plant.

The dreaded Mexican boll weevil, *Anthonomus grandis*, which causes such enormous losses in the United States, fortunately has not effected an entry in East or West Africa.

The larvæ of some of the moths are formidable enemies to cotton. The Egyptian cotton boll worm, *Earias insulana*, which is spread over Africa, India, and Australia, occurs

in German East Africa. The moth is a small greenish-yellow insect with a wing span of 20 to 22 millimetres. The eggs are laid on the leaf or on the growing tips or on the capsule. It is combated by clearing away weeds from the cotton plant, by collecting and burning the attacked capsules and tips, and by burning all the old plants after harvest. The larvæ feed also on other plants, and *Hibiscus esculentus* has been tried in India as a trap crop. In India, too, the introduction of an ichneumon fly, *Rhogas Lefroyi*, is said to have materially diminished the pest, and an attempt is being made to establish this fly in Egypt.

Another moth, the Egyptian cotton worm, *Prodenia litura*, and the moth just described are the greatest enemies of cotton in Egypt, but in German East Africa *P. litura* does not appear to be abundant on cotton. The eggs are laid in masses on the underside of the leaves and are covered with hairs which protect them from the wet. The larvæ when young attack in large companies the under-surface of the leaves; when older they gnaw the edges. The old worms hide during the day in the ground and only come out at night or in dull weather to feed on the plants. The change into a chrysalis is made in the ground. Besides cotton it feeds on maize and many other plants, and it occurs all over the tropical and subtropical regions of the Old World. The eggs should be carefully sought out and destroyed.

The common cotton boll worm, *Chloridea obsoleta*, is widespread in German East Africa, but so far has not been observed on cotton plants. It is a very wide-spread insect in the world and feeds on many plants; the use of insecticides and of maize as a trap crop for it have been recommended.

The pink boll worm, *Gelechia gossypiella*, is the worst cotton pest in East Africa; it is universal and every year destroys a proportion of the capsules. These are the only part of the plant that it attacks, and as soon as the first of them are set, the moths lay from one to three eggs on each. After hatching the worms bore their way to the seeds, which they eat out. The entrance hole cicatrises and the worm gets ready an exit hole and then pupates in the hollow seed or in a bore hole. In older capsules the worm pupates either in an empty seed or between several seeds, and the seed stored for use still contains the insect in some form. The life cycle of the insect in the active period lasts from four to six weeks; the first attack of the year is always slight, and subsequent attacks get more and more severe. The winter seems to be passed in or among the seeds, but this is not quite established; it may perhaps be passed by the aid of other food plants. It is combated by collecting all the attacked

capsules as soon as possible and by clearing away and burning the old plants after the harvest. During the harvest, too, all attacked capsules should be put by the cotton gatherers into a separate sack and burnt each day. A further precaution is to expose the gathered material on metal plates in the sun and thus destroy the worms. Spraying is unsuitable, but the seeds might be disinfected with carbon disulphide; not with hydrocyanic acid, however, since this has been found ineffective.

Of the cotton stainers, *Dysdercus* spp., four occur in German East Africa, as also does *Oxycarenus hyalinipennis*, but in general the damage they do is insignificant.

In one year enormous quantities of snails appeared in the south of the Protectorate and large places in the cotton fields were eaten bare by them, and sometimes the cotton plants were broken by the load of snails. They came from the surrounding bush and grass-land, and the remedy proposed was to make ditches of water round the fields so that the snails could not pass. Such an attack, however, seems very exceptional.

The Source and Industrial Uses of Beryllium Compounds.—The preparation of the beryllium nitrate, used in the manufacture of incandescent gas mantles, has hitherto been carried on entirely in Germany. As a consequence of the European war there was a temporary scarcity of this and other beryllium salts, but it is understood that British chemical manufacturers are now prepared to put these salts on the market. The industry is a small one, but as the matter is of considerable interest the following note as to the source and uses of these salts has been prepared.

Beryllium, or glucinum, is a constituent of many minerals, few of which are found in any quantity. The only important one is *beryl*, the better-class varieties of which are valued as gemstones.

Beryl is a silicate of beryllium and aluminium, usually of a pale green colour. It has a hardness of 7·5 to 8, specific gravity 2·6 to 2 8, a vitreous lustre and conchoidal fracture. It often occurs, as an accessory mineral, in pegmatitic granite veins, in hexagonal prisms which sometimes attain a great size.

The mineral is of common occurrence in the pegmatites of India, and large crystals have been found in the mica mines of Behar and Nellore. In the United Kingdom it has been found in the Mourne Mountains of Co. Down, and at Killiney near Dublin, Rubislaw near Aberdeen, and St. Michael's Mount, Cornwall.

In New South Wales, beryl occurs, associated with tinstone, at Elsmore, Mole Tableland; with felspar, quartz, and mica at Ophir, Wellington Co.; at Shoalhaven River, east of Bungonia; and in alluvial deposits at Emmaville, Kangaroo Flat, Tingha Copes Creek, and Scrubby Gully.

In the United States, beryls of great size have been found in New Hampshire and Massachusetts, certain of which weighed over one ton. The mineral has also been found in many other localities in the United States, Russia, Sweden, Norway, Colombia, Brazil, etc.

The following is a typical analysis of beryl:

		Per cent.
Beryllium oxide	BeO	12·64
Aluminium oxide	Al_2O_3	17·05
Ferric oxide	Fe_2O_3	2·20
Lime	CaO	0·57
Soda	Na_2O	0·68
Silica	SiO_2	65·24
Water	H_2O	2·70

Preparation of Beryllium Compounds.—Several processes are available, of which the following may be mentioned. The finely powdered beryl is mixed with twice its weight of dry potassium carbonate and fused for three hours. The melt is treated with a slight excess of dilute sulphuric acid, and the whole evaporated until the excess of acid is removed. Water is then added, the insoluble silica removed by filtration, and the solution concentrated so that, on cooling, the greater part of the aluminium crystallises out as potash alum. The mother liquor, which now contains sulphates of beryllium and iron together with a small amount of alum, is poured into a saturated solution of ammonium carbonate, and allowed to stand for several days. By this means most of the iron and aluminium separates out, and is removed by filtration. The solution in ammonium carbonate is next treated with superheated steam, which causes the beryllium to be precipitated as a basic carbonate.

By repeating this solution in ammonium carbonate, and precipitation with steam several times, a fairly pure product can be obtained.

The preliminary fusion with potassium carbonate may be replaced by one using six parts of ammonium fluoride to each part of beryl, and continuing the heating for ten to twelve hours. On extracting the mass with water, most of the aluminium remains as the insoluble fluoride, and the filtrate is evaporated with sulphuric acid to remove the silica and hydrofluoric acid. The solution is diluted and treated with ammonium carbonate as above. From the carbonate so obtained, other salts, such as the nitrate, can be readily prepared by well-known methods.

Commercial Utilisation of Beryllium Compounds.—Very few uses have been found for salts of beryllium, and, so far as can be ascertained, the only industry which calls for regular supplies is that of making incandescent gas mantles. In the solutions of thorium salts used for impregnating the

ramie, cotton, or artificial silk "stocking," a small quantity of beryllium nitrate is sometimes used in order to give increased strength to the ash skeleton which will remain after ignition. The quantity of beryllium salt added rarely exceeds 0·5 per cent. of the weight of thorium nitrate present in solution. Beryllium acetate has been suggested for use as a catalyst in the preparation of certain organic compounds.

In the past it would appear that the small trade in beryllium minerals, other than gemstones, has been largely centred in Hamburg. Recent prices are not obtainable, but during 1911 high-grade beryl sold at £2 to £2 10s. per 100 kilos. c.i.f. Hamburg. The mineral was then largely obtained from Norway, one producer stating that he sold from 3 to 10 tons per annum.

RECENT PROGRESS IN AGRICULTURE AND THE DEVELOPMENT OF NATURAL RESOURCES

In this section of the BULLETIN *a summary is given of the contents of the more important papers and reports received during the preceding quarter, in so far as these relate to tropical agriculture and the utilisation of the natural resources of the Colonies, India, and the Tropics generally.*

SOILS

Droughts and Soil Erosion in South Africa.—The inland portion of the Union of South Africa is exceedingly liable to droughts, which are steadily increasing in severity and are accompanied by serious soil erosion, with the result that certain large areas of land have already been rendered useless and many other areas are threatened with the same fate. In view of these facts a Select Committee was appointed in March 1914 to consider the question of droughts, rainfall, and soil erosion, and their Report has now been issued, together with the Proceedings of the Committee, Minutes of Evidence, and Appendix [*Senate S.C.* 2—1914].

The consideration of the Committee was devoted to four subjects: (1) The rainfall of South Africa: its occurrence and variation; (2) erosion of the soil: its causes and extent; (3) desiccation; and (4) possible remedial measures.

With regard to the rainfall, there does not appear to have been any definite diminution during the period for which records are available. There has always been considerable variation in the distribution and nature of the rainfall from year to year and from month to month, and this variation increases with the distance from the coast. Some evidence has been obtained indicating that there

are periods of maximum and minimum rainfall corresponding with certain cycles, but this is not sufficient to enable any such cycles to be defined. The condition of the soil and the vegetation on it do not affect appreciably the total amount of the rainfall, although it probably influences its local character and distribution.

When erosion of the soil has commenced, its continuation is greatly facilitated by the high elevation of the South African sub-continent and the consequent rapid run-off of the rain-water. Various agencies have contributed to the denudation of the soil, such as the burning of the veld, the cutting of trees and bush for fuel or timber, railway construction, and the grazing of stock. Much damage has been caused by the way in which roads and tracks have been made; in many parts these have been laid without any regard to construction or drainage, and become converted by the ordinary traffic of the country into channels, down which the rain-water rushes from the slopes into the main valley, carrying with it the loosened portions of the surface soil. The combined effect of these different factors has resulted not only in the waste of rain-water which would have been of great value to agriculture, but also in causing the irretrievable loss of much of the richest soil.

There is no doubt that, in spite of the apparent constancy of the total rainfall, many parts of the Union have been gradually drying up at a rate varying with the locality, soil, and gradients. Unless this process is checked, such parts of the country must ultimately become useless and uninhabitable. The direct cause of the desiccation is the erosion of the soil and the consequent diminution or disappearance of the water-supply.

The erosion has progressed to such a vast extent and for so long a time as to render it impossible to check it completely. Various measures are suggested for reducing and controlling the evil. These include (1) the instruction of the public by means of pamphlets and lectures with regard to the seriousness of the danger, the causes and effects of erosion, the best means of stopping sluits, and the most suitable trees and grasses to grow for the purpose; (2) the periodical inspection of districts in which erosion is in active progress; (3) the encouragement of fencing and the construction of dams and irrigation works; (4) legislation against indiscriminate veld-burning; (5) the regulation of grazing; (6) the encouragement of the judicious planting of trees and sowing of grasses; (7) the proper construction, drainage, and upkeep of roads; and (8) the minimising of erosion in connection with both existing and future railways. It is pointed out that the greatest obstacle to the attainment of rapid results is the sparsely populated state of the country, and it is considered that

a closer settlement of the land would render efforts to check erosion much more effective in all respects.

Treatment of Hard-pan Land in Egypt.—On some kinds of land a hard, impervious layer is formed at a little distance below the surface of the soil; it prevents drainage and stops the penetration of roots, and consequently impairs the fertility of the soil. This layer is known as hard-pan, and is caused by different agencies in different places, such as organic matter, iron compounds, siliceous compounds, etc., or it may be caused by sodium carbonate in the soil.

In the Nile Delta there are several localities where nothing will grow owing to the presence of sodium carbonate. On one estate an endeavour to wash the sodium carbonate out of the soil produced a hard-pan at some depth below the surface, so that water stood on the surface whilst the surrounding drains remained only slightly moist, showing that percolation had practically ceased. An account of the way it was treated and the condition ameliorated is given in the *Agric. Journ. Egypt* (1914, **4**, 61). At first an attempt was made to break up the pan by the use of explosives. Gelignite cartridges were exploded at a depth of about 30 in. and at a distance of 4 or 5 yards apart. The explosion of these should have caused radiating cracks in the hard-pan, but the land was so wet that in most cases the effect was merely to blow up the soil above the cartridge, and the water still stood for days in the hollows caused by the explosion. The area treated was about five-twelfths of an acre, and the cost of the explosives was a little over £2, 24 lb. of gelignite being used, with the necessary detonators and fuse.

The next attempt was more successful; this was to apply gypsum in order to decompose the sodium carbonate. Three applications of this were made in dressings of $15\frac{3}{4}$ cwts., $17\frac{3}{4}$ cwts., and $14\frac{3}{4}$ cwts., with frequent ploughings. The result was that the whole nature of the soil seemed greatly improved; and this was probably due far more to the gypsum than to the explosives.

Foodstuffs

Coffee.—The export of coffee from the East Africa Protectorate during the year 1912-13 amounted in value to £10,680, having increased each year from £1,068 in 1909-10 (*Ann. Rep. Dept. Agric., Brit. East Africa*, 1912-13). The discovery of *Hemileia vastatrix* on two plantations caused uneasiness amongst planters. It was found that the disease had been in existence on a third plantation for some years without however having a serious effect on the yield of coffee. This information, together with the fact

that in German East Africa coffee has been grown with substantial profit for the last ten years, notwithstanding the presence of Hemileia, has given encouragement to plantation owners, and further it has been found that the disease is not proving so disastrous as was at one time feared. A series of experiments was conducted with various fungicides, but the results did not indicate the prospect of any substantial benefit from spraying as a general practice. A similar result was obtained in India.

Sugar.—*The Rep. Dept. Science and Agric., British Guiana*, 1912-13, records the results of further manurial trials with sugar-cane during a season in which the rainfall was much below the average. Contrary to the results obtained in other years, the manurial value of nitrate of soda proved higher than that of sulphate of ammonia, for which in normal years the sugar cane shows a marked preference. In seasons when the period of active growth is short, nitrate of soda and nitrate of lime may be more efficacious than sulphate of ammonia, dried blood, cyanamide, and other more slowly acting nitrogenous manures.

The results obtained by the application of vacuum-pan molasses at rates of 100 to 300 gallons per acre indicated that molasses exerted no appreciable action on the crop to which it was applied, and that its application resulted in a financial loss. Whether it exerts a beneficial action on later crops has not yet been determined. It is alleged to have a favourable action on soil bacteria.

According to the *Report, Government Statistician, Queensland, on Agricultural and Pastoral Statistics* for 1913, the cane crop of Queensland for 1913 surpassed in quantity and quality all previous harvests in this state. There were in 1913 147,743 acres under cane, of which 102,803 were cut for crushing, yielding 242,837 tons of sugar, as against 141,652 acres cultivated in 1912, of which 78,142 were cut for crushing, yielding 113,060 tons of sugar. The best average cane return per acre was in Wide Bay, where 21·7 tons were harvested, while the best average return of sugar per acre was obtained in Edgecumbe, and amounted to 2·43 tons. Of the total Australian output of sugar in 1913, amounting to 266,267 tons, Queensland produced 91·2 per cent., and New South Wales 8·5 per cent., while Victoria contributed 857 tons of beet sugar, representing 0·3 per cent. of the total.

The value of the Nipa palm (*Nipa fruticans*) as a commercial source of sugar is discussed in *Philippine Journ. of Science* (1913, **8**, 377). The Nipa palm covers large areas of swamp land in various parts of the tropics and has but few requirements for successful growth, among which may be mentioned low river land subject to periodic flooding. The sap at present is utilised as a commercial source of alcohol, and is collected in bamboo joints or "tuquils" from

the cut flower stalks, where it is slowly exuded. Owing to the inversion and fermentation which take place during the collecting process now employed, the sap is useless for the manufacture of sugar. As a result of the experiments carried out by the Philippine Bureau of Science this difficulty has been overcome in the following manner. The sap is collected in bamboo joints containing a small amount of lime-cream and sodium bisulphite. The lime prevents inversion of the sucrose, and the sulphite destroys an enzyme of the peroxidase class present in the sap which is capable of rapidly destroying both sucrose and invert sugar. By the use of a small funnel the sap is conveyed to the bottom of the tuquil and stratification with the resulting uneven preservation is prevented. It is stated that Nipa sap can be collected and delivered at a mill at a cost of 1,000 litres for 1½ dollars (U.S. currency), and this quantity of sap yields 115 kilograms of commercial white sugar, polarising at 99° to 99·5°. A 10-ton mill running at full capacity requires 90,000 litres of sap daily, which would be supplied by a swamp of about 1,100 acres. Further details of extraction are given, and it is stated that the production of sugar from Nipa palm would be less expensive than from cane or sugar beet.

An account of the sugar palm (*Arenga saccharifera*) is contained in *Philippine Agric. Review* (1914, **7**, 216, 222). In the Philippines the sap is a source of alcohol, vinegar, starch, and sugar, but owing to the protein substances held in solution, and to the rapid fermentation of the sap, it has not been possible to produce a first-class sugar. The article records experiments in which formalin was found to be the most satisfactory preservative of the juice, and that by heating the sap to the boiling point the protein and pectous bodies were precipitated. One tree, it is stated, yields about 385 kilograms of sap per year, containing 14 per cent. of sucrose.

Wheat.—*The Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, contains an account of wheat-breeding experiments conducted on the Kabete Experimental Farm and on Lord Delamere's Farm at Njoro. A list of forty-seven varieties, showing the yield and dates of harvesting, is given. A number of wheats have been produced which have now successfully withstood rust infection for three consecutive seasons, and which, in addition to this property, possess a good yielding capacity, with stiff straw and awnless ears.

Oils and Oil Seeds

Cocoanuts.—The interest in coconut planting in British Guiana is increasing, and considerable expansion is expected (*Rep. Dept. Science and Agric.*, 1912–13, p. 9).

The total area under coconuts in 1912 was 13,698 acres. Little attention is paid to drainage, and overcrowding occurs on the older plantations, but there is an improvement in spacing in newer plantations. On neglected plantations disease is prevalent and many trees die for want of drainage. Bud-rot is not uncommon in some parts, and beetles were prevalent in many plantations, while the caterpillars of *Brassolis sophorae* have caused much damage. Legislation will be necessary to deal with insect and fungoid pests.

From Jamaica the export of coconuts showed an increase in 1913 of 820,000 nuts over that of 1912, in spite of adverse conditions in the west of the island, due to cyclones in the previous year (*Rep. Dept. Agric. Jamaica*, 1913–14, p. 15). Bud-rot is under control in the important coconut districts, but the fungoid leaf disease known as "leaf-die-back" proved troublesome in some localities.

The development of coconut planting in the East Africa Protectorate is slow, considering the large area of suitable land in the coast-belt (*Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, p. 16). This is due mainly to the difficulty of land allotment owing to tribal claims. The *Oryctes* beetle has been present for many years, and legislation will be necessary to compel the natives to destroy the dead trees which form breeding grounds for this pest. Bud-rot appeared on two plantations grown from seed obtained from Ceylon and Pemba. All affected trees have been destroyed and the importation of seed has been prohibited, as good local seed is available.

Bordeaux mixture has been tried in Surinam as a remedy for bud-rot (*Trop. Agriculturist*, 1914, **43**, 21; and this BULLETIN, 1914, **12**, 645). It appears to exert a favourable influence, although it is not an absolute cure. Ten-year-old palms require about 1½–1¾ gallons each.

Ground Nuts.—An account is given in *L'Agron. Col.* (1914, **2**, 1, 34) of experiments which have been made in French West Africa in connection with the cultivation of ground nuts. It was found that the China and Burma varieties possessed characteristics which render them unsuitable for cultivation in Senegal. The best results are stated to have been obtained from the Kafrine and Sine Saloum varieties.

Linseed.—An account is given in the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, pp. 90, 110, of trials which have been made in the cultivation of linseed in the East Africa Protectorate. It is stated that "at the Kibos experimental farm the results after three years' trial are hardly of a sufficiently satisfactory character to warrant the widespread cultivation of linseed at Kibos. At the Nairobi experimental farm, Kabete, on the other

hand, excellent crops of seed are stated to have been obtained. Ten acres of land were planted with Riga seed during 1912 at Kabete, and the yields obtained were at the rate of 720 lb. of seed per acre.

Olive.—According to *Der Tropenpflanzer* (1914, **18**, 350), experiments have been in progress for some time in Leganga, German East Africa, in connection with the cultivation of olives. Trees were obtained from Palestine and planted in the Kilimanjaro and Meru districts, where the olive tree also occurs wild. The results of the experiments are stated to have been encouraging.

Sesamum.—Two varieties of sesamum have been experimentally cultivated in Rhodesia for several seasons, but although the plants grow very readily the yield of seed is said to be too low to make its cultivation remunerative (*Rhodesia Agric. Journ.*, 1914, **11**, 907). The yields per acre of the white and yellow seeded varieties are stated to have been only 140 lb. and 224 lb. per acre respectively.

Soy Bean.—The *Board of Trade Journ.* (1914, **86**, 385) states that a new experimental bean mill belonging to the South Manchuria Railway Company has started operations at Ji-ji-ko, about two miles from the Dairen wharves. The mill is the only one in Dairen which extracts soy bean oil by the benzine process, and the experiment is being made in order to see whether the more modern method could be profitably employed in Manchuria. The mill is equipped for the manufacture of crude oil and bean meal from soy beans, and for the refining of the crude oil obtained. It is said to have a maximum capacity of 80 tons of beans per day of 24 hours, but at present only 50 tons per day are treated, producing 7 tons of oil and 40 tons of meal. It is stated that it is impossible to say yet whether the experiment will give satisfactory results from a commercial point of view, as the capital cost of the mill is much greater than for a mill of the ordinary type, and the crude oil must be refined and deodorised before being put on the market.

Miscellaneous.—A monograph by E. W. Thompson entitled *Cottonseed Products and their Competitors in Northern Europe*, Part 1, Cake and Meal (*U.S. Dept. Commerce, Special Agents Series*, No. 84, 1914) has already been referred to in this BULLETIN (1914, **12**, 462, 576). The chief aim of the author is to point out the possibilities of placing larger quantities of American cotton-seed cake and meal on the various markets of Northern Europe. The trade and agriculture of Germany, the United Kingdom, the Netherlands, Denmark, Norway, and Sweden, as affecting cotton-seed cake and similar materials, are discussed in a most able

manner: while the methods of manufacture and utilisation of oil cakes are described, and lists of names of manufacturers and buyers of oils and oil cakes are also given. Although the primary object of this work is to show American manufacturers methods of extending commerce, the information given cannot fail to be of great value to all who are interested in the oil and oil cake trades, especially at the present time.

According to the *Journ. Soc. Chem. Ind.* (1914, **33**, 556), the Bureau of Science of the Philippine Government is investigating a new oil-nut from the island of Catanduanes. The nuts were forwarded by the natives as candle nuts, but it is thought that they are derived from a species of *Amoora* or *Dysoxylum*, N.O. Meliaceæ. The dry nuts are said to contain 45 per cent. of a dark, fatty, non-drying oil, unsuitable for edible purposes, but producing, it is stated, a good commercial soap.

An account is given of "Analyses and Uses of Brazilian and Indian Nutmegs" in a booklet by A. G. Turner, published recently in Liverpool. It is stated that the wild nutmegs of South America and India yield fats of considerable value to soap and candle manufacturers, but that there is some doubt as to the quantity of material available, although there is apparently a possibility of ucuhuba nuts (*Myristica bicuhyba*) being shipped in quantity to the English market from Brazil. It is stated also that if the seeds of *M. canarica* could be obtained in large quantities there would be a ready market for them, as they compare favourably with seeds of the same species obtained from other countries.

According to Davidsohn (*Seifenfabrikant*, 1914, **34**, 178), rice oil on keeping separates into a liquid oil and a solid fat. Constants of both are given, and it is stated that the oil is suitable for the manufacture of soft soaps, whilst the fat (the mixed acids from which melt at 39·6° C.) is suitable for hard soaps.

An account is given in *Journal d'Agric. Tropicale* (1914, **14**, 171) of fruits and seeds of *Balanites Tieghemi*. The kernels, which comprise 21 per cent. of the seeds, are from 1 to 2 in. in length, and yield 10 per cent. of a liquid yellow oil containing 63 per cent. of unsaturated acids. It is stated that the colour and taste of the oil prevent its use as an edible oil, but it is regarded as suitable for soap making. Constants of the oil and the results of analysis of the cake are given.

The total capacity of hydrogenating plants for the hardening of liquid oils (see this BULLETIN, 1913, **11**, 660) in Europe in 1914 has been estimated to be about 1,375,000 lb., but only about one-half of this quantity was manufactured in 1913 (*Journ. Soc. Chem. Ind.*, 1914, **33**, 837). In the United States of America there existed in 1913

plant capable of turning out about 500,000 lb. of hydrogenated oils, and the industry is increasing rapidly. In Europe linseed oil has been used, chiefly owing to its present low price; cotton-seed oil has been used for the preparation of edible fats. Manufacturers of compound lard in the United States who previously used 20 per cent. of oleo-stearin (animal fat) now use only hardened cotton-seed oil. In Germany the two largest factories making hardened oils are the Bremen-Besigheimer Oelfabrik, where only edible fats are produced under the name "Brebesol," and the Germania works at Emmerich, which produce hardened oils for technical use, such as "talgol" and "candelite," from whale and fish oils (*Journ. Soc. Chem. Ind.*, 1914, **33**, 872). The former works employ the Messerschmidt iron-contact process for generating hydrogen at a cost of about 1*s.* 1¼*d.* per 1,000 cubic feet.

Rubber

Hevea brasiliensis.—According to Dr. Arens, who made a tour recently through Ceylon and Malaya, little or no systematic attempt has been made to plant selected Para rubber seed in these countries (*Trop. Agriculturist*, 1914, **43**, 10). In Java many plantations have been made already, from seed of specially good trees, and the author cites the results obtained with cinchona in Java as an example of what may be done by attention to selection. A note by the editor of the *Tropical Agriculturist* states that a field has been planted at Peradeniya with seed from the well-known tree at Henaratgoda, which has yielded 386 lb. of rubber in four years.

The growth of Hevea trees in British Guiana is satisfactory when planted on suitable land, such as that which has supported a heavy forest growth. The industry is expanding slowly, there being 2,800 acres under *Hevea brasiliensis* in the year 1912-13 (*Rep. Dept. Science and Agric., Brit. Guiana*, 1912–13, p. 10). In that year nearly 120,000 plants were raised from seed imported from Ceylon and the Straits Settlements, while over 110,000 stumps were imported from Ceylon and Surinam.

According to the *Rep. Dept. Agric., Jamaica*, 1913–14, p. 15, eight-year-old Hevea trees tapped for six months yielded only a small amount of scrap rubber, showing that Hevea is unsuitable for cultivation in Jamaica; no details as to method of tapping or state of growth of the trees are given.

The growth of Hevea trees in Nyasaland is stated to be about two years behind that in Ceylon (*Rep. Dept. Agric., Nyasaland*, 1913–14, p. 10), but considering the drought to which they have been subjected their growth appears to be satisfactory. Experimental tapping of some trees has given satisfactory results. There are over

100,000 trees from one to seven years old on the plantations of the African Lakes Corporation, Ltd.

In *Bulletin* No. 19, 1914, *Dept. Agric., Fed. Malay States*, A. Sharples describes the various fungi which cause spots on rubber, and discusses the conditions which favour the formation of spots and also methods of prevention. The main conclusions arrived at are: (1) Spotting and discoloration of plantation rubber are generally due to common saprophytic fungi (*Penicillium* sp., *Fusarium* sp., etc.), which contain proteolytic enzymes. (2) Infection takes place in the latex in the field; infection of the rubber after preparation only takes place under abnormal conditions in the drying sheds. (3) The best methods of prevention are treatment of the latex by formalin and quick drying of the rubber by thinner working and "addition of sodium bisulphite," although the author's evidence that sodium bisulphite accelerates drying does not appear very conclusive. (4) Dilution of the latex with water tends to enhance the danger of spotting. (5) Excess of coagulant also increases the tendency towards spotting. The *Bulletin*, which contains the results of much original investigation, will be of considerable value to rubber planters.

Funtumia spp.—According to the *Bulletin agricole du Congo Belge* (1914, **5**, 95) *Funtumia elastica* occurs wild in abundance in all the forests of the Bangala district, Belgian Congo. Plantations have been made at Musa and Kutu since 1904; those in the latter place were made, however, in cleared forest, and the results were unsatisfactory, while the Kutu experiment station has since been abandoned. In experiments carried out with 620 trees eight to nine years old at Musa, tapped on alternate days over a period of ten or eleven days, nearly 134 lb. of rubber, containing from 15 to 20 per cent. of moisture, were obtained; allowing 20 per cent., the yield of dry rubber is equivalent to $2\frac{3}{4}$ oz. per tree. The trees could probably be tapped twice a year, and including scrap, a yield of about 6 oz. of dry rubber per tree per year may be expected. The trees were planted at distances of 3 × 3 metres, the yield per hectare being calculated at 407 lb. of dry rubber per year, equivalent to 164 lb. per acre. Experiments with a large number of trees at Kutu gave similar results. The cost of production was somewhat high (about 7*d.* per lb.) owing to unskilled tapping. The rubber was valued at about 2*s.* 2*d.* per lb., with plantation Hevea rubber at 2*s.* 4*d.* per lb.

Miscellaneous.—The cultivation of *Sapium* in British Guiana has not given promising results (*Rep. Dept. Science and Agric.*, 1912–13, p. 10), and most of the plantations will be abandoned.

According to the *Rep. Dept. Agric., Nyasaland*, 1913–14,

p. 10, Ceara trees only produce satisfactory yields in that country when grown on rich soil retentive of moisture and in localities with a rainfall of not less than 40 in.

Fibres

Silk.—In the *Rep. Dept. Agric., Travancore, for the Year* 1912–13, an account is given of an effort which is being made to encourage silk culture. Experiments have been carried out at the Chingom Silk Farm with both mulberry and eri silkworms and with mulberry and castor-oil plants. The chief attention has been given to the eri silkworm, as this is regarded as more likely to become popular with the natives. Lectures and demonstrations have been given at several places, and leaflets on sericiculture have been distributed broadcast. Mulberry cuttings, castor-oil seeds, and silkworm eggs have been supplied to a number of persons, and considerable interest in the industry has been aroused. There is no doubt that Travancore is well adapted to sericiculture, and it is hoped that it will be taken up largely as a cottage industry.

Flax.—The experiments on flax cultivation which have been conducted for many years by the Department of Agriculture and Technical Instruction for Ireland (compare this Bulletin, 1903, **1**, 188; 1912, **10**, 498; 1913, **11**, 532) have been continued, and an account of the work accomplished during 1912 is published in the *Journ. Dept. Agric. and Techn. Instr., Ireland* (1914, **14**, 515). The use of steamed bone flour as a manure has been tested for four successive years and has given adverse results. As similar results were obtained in earlier experiments with other phosphatic manures, viz. superphosphate and basic slag, it is now definitely concluded (1) that in the districts in which the experiments have been carried out, phosphates cannot be profitably applied to flax, and (2) that this is due to the fact that they encourage the growth of weeds to such an extent as seriously to reduce the flax crop. A series of trials on the application of lime and muriate of potash to the flax crop, the lime being applied the previous year to oats, have indicated that the liming of the land one year in advance is of considerable benefit and that muriate of potash forms a valuable supplemental dressing to lime. Further experiments are needed, however, before definite recommendations can be made. In the course of special trials of Russian, Dutch, and Irish flax seed, results have been obtained which indicate that an improved variety of flax can be obtained by the process of selecting seed from plants with long stalks.

In the *Ann. Rep., Dept. Agric., Brit. East Africa*, 1912–13, it is stated that the flax plant has been grown in several districts of the Protectorate during the last two

years for the production of linseed only, the straw being burned (see p. 620). A small quantity of fibre was prepared however, as an experiment, and this was so favourably reported on that the services of a flax expert from Courtrai, Belgium, were secured. This expert has demonstrated that fibre of a high quality can be produced in the East Africa Protectorate. A sample of the flax was valued by a London fibre merchant at £65 per ton, a price which was only £10 per ton below that of the best Belgian flax. The cultivation of flax is being extended and a scutching factory has been established at Lumbwa. A crop of over 2½ tons per acre has been obtained at Kabete on unmanured land, and as all the work involved, except scutching, can be carried out by unskilled labour, it is expected that the industry will undergo a rapid development. It may be mentioned that samples of flax grown in the East Africa Protectorate have been examined at the Imperial Institute, and these also proved to be of excellent quality (this BULLETIN, 1914, **12**, 211).

Sisal Hemp.—A record of the progress of the sisal hemp industry in the East Africa Protectorate is given in the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13. The returns from the plantations have been so satisfactory that a considerable extension of the industry is anticipated. At the end of 1912, the total area under cultivation was about 7,000 acres, distributed as follows: Punda Milia, 1,000 acres; Makuyu, 750 acres; Voi, 1,000 acres; Nyali, 1,000 acres; Powysland, 1,160 acres; Gazi, 1,000 acres; Maseno, 600 acres; other areas, about 490 acres. Several improvements have been made in the decorticating machinery, and simplified methods of brushing and drying the fibre are being adopted which will effect an economy in labour. Sisal plants grown at the coast yield a higher percentage of fibre than those grown in the highlands and also furnish a finer fibre, but in the highlands a larger yield per acre is obtained and the cost of labour is less. The following data were obtained as the result of certain tests carried out at Punda Milia. From 912 leaves, weighing 2,263 lb., or an average of 2·48 lb. per leaf, a yield of 52½ lb. (2·32 per cent.) of dry, brushed fibre was obtained, or about 1 lb. of fibre from 17 leaves. The plants from which these leaves were cut were spaced 8 ft. × 8 ft., this arrangement giving 681 plants per acre. Taking 160 as the average number of leaves produced per plant during its life, the total yield per acre, when calculated by the above figures, is 6,240 lb., or a little less than 3 tons. Considerable attention is being devoted to the question as to the best treatment of the land after the full crop has been gathered in order to render it fit for further planting. It is suggested that the stumps would dry more quickly if small quantities of arsenite of soda were injected into

them. They could then be collected and burned and the land ploughed again before weeds had become established to any great extent. Experiments are being conducted on these lines at Punda Milia.

An interesting account of the present position of the various sisal hemp estates in the Protectorate is given by the Chief of the Economic Plant Division. The experience gained by Messrs. Swift and Rutherford at Punda Milia has led to the following conclusions: The establishment of a plantation of 1,000 acres requires a capital of £4,000. The cost of machinery required to prepare the fibre from leaves produced on 1,000 acres is £5,000. A return cannot be expected until at least four years after the plantation has been established. One ton of dry fibre per acre per annum may be anticipated for three years from the date of the first cutting. The cost of producing a ton of dry fibre is about £12, including £1 per ton for transport to the railway.

New Zealand Hemp.—An account of the New Zealand hemp (*Phormium tenax*) industry in St. Helena during 1913 is given in *Colonial Reports, Annual*, No. 799, *St. Helena, Report for* 1913 [Cd. 7050–40]. The quantity of leaves treated at the Government mill amounted to 1,296 tons, and yielded 128 tons of fibre and 39 tons of tow. The fibre realised an average price of £28 10*s.* per ton, and the tow £14 10*s.* per ton. The year's working resulted in a net profit of £137, and the results are regarded as very satisfactory. A new mill was opened by a private firm in July 1913, and by the end of the year had dealt with 589 tons of leaves, with the production of 38 tons of fibre and 14½ tons of tow. The amount of phormium now under cultivation is considered sufficient to ensure a continuous supply of leaves to both mills. Further planting is being carried out every year, and ere long there should be enough material available to justify the erection of a third mill.

Paper-making Materials.—The attention of the Research Institute, Dehra Dun, India, has been drawn to "moya" grass (*Pennisetum Alopecuros*) as a possible paper-making material. It is reported in the *Indian Forester* (1914, **40**, 291) that this grass yields 39 per cent. of pulp, which can be easily bleached, and is similar in quality to that obtained from baib grass (*Ischaemum angustifolium*). Moya grass is said to grow over large areas in the hills of the Central Provinces, and to be capable of collection at a low cost. It is considered that in the neighbourhood of the Pench Valley coalfield 15,000–20,000 tons could be collected annually and delivered at a suitably situated factory site at a cost not exceeding Rs. 15 (£1) per ton.

A sample of the stems of *Hedychium flavescens* has been forwarded to Kew by the Director of Agriculture, Ceylon,

in order that its paper-making qualities might be compared with those of *H. coronarium* (cf. this BULLETIN, 1913, **11**, 163; 1914, **12**, 487). This material has been tested by Messrs. Clayton Beadle and Stevens, and their report has been published in the *Kew Bulletin* (1914, No. 5, p. 193). The results of the investigation show that the stems of *H. flavescens* furnish a paper of similar character to that afforded by the stems of *H. coronarium*, but in somewhat lower yield.

Cotton

Uganda.—The cotton industry of Uganda has continued to make remarkable progress, especially in the Eastern Province. The *Ann. Rep Dept. Agric., Uganda, for the year ended March* 31, 1914, states that the total area devoted to cotton in that year amounted to 83,714 acres, consisting of 33,738 acres in the Teso District, 25,000 acres in the Busoga District, 20,104 acres in the Bukedi District, and 4,872 acres in the Lango District. The exports amounted to 85,217 cwts. of ginned cotton of value £272,366, and 44,130 cwts. of unginned cotton of value £45,321. The further extension of the industry is seriously hampered by the difficulties of transport. The whole of the main crop of cotton during the season under review was of Allen's Long Staple variety. During the 1914–15 season the same variety will be grown over the greater part of the country, but about 6,000 acres will be planted with a selection of the Sunflower variety produced at the Kadunguru seed-farm.

East Africa Protectorate.—It is stated in the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, that the experience of several years has proved that the cultivation of cotton in the coast belt is not profitable, except on the banks of the Tana and Juba Rivers, where irrigation can be effected. In the Lake District of the Nyanza Province, however, favourable conditions of soil and climate exist, and cotton growing is being taken up by the natives as an adjunct to the cultivation of sim-sim (sesame) and other food crops; it is anticipated that in the near future considerable quantities of cotton will be exported from this district.

Nyasaland.—An account of the cotton industry in Nyasaland is given in the *Ann. Rep. Dept. Agric., Nyasaland Protectorate, for the year ending March* 31, 1914. The area devoted to the crop by European planters during the season 1913–14 amounted to 25,697 acres, of which 160 acres were planted with Egyptian cotton and the remainder with the Nyasaland Upland variety. The total exports amounted to 6,003 bales of 400 lb., as compared with 8,093 bales in the previous year; the decrease was due to the failure of the crop in the Shire Highlands, owing to unfavourable climatic conditions. The cotton grown on many of the

estates showed a decrease in length, and planters are strongly advised to procure seed yielding cotton of a length of $1\frac{3}{16}$ in. instead of $1\frac{1}{8}$ in., as the difference of $\frac{1}{16}$ in. in length makes a difference of at least 1*d.* per lb. in the value of the cotton Cotton growing by the natives continues to undergo a steady extension, and during the year under review the crop amounted to 1,811 bales of 400 lb., as against 1,126 bales in 1912-13.

Jamaica.—The cotton crop of 1913 attained the value of £4,000. It consisted of the Sea Island variety, and was mostly grown by the small holders in Vere (*Ann. Rep. Dept. Agric., Jamaica, for the year ending 31st March 1914*). The 1914 crop, however, failed on account of an abnormal season, and planters have therefore sought for a more hardy variety for general cultivation. A perennial tree-cotton has been introduced from Cauto in Cuba, and has given very promising results. This variety is expected to form the basis of a reliable industry for both large and small growers in the drier districts of the island. Experiments are also being made with three kinds of Egyptian cotton, including the Sakellaridis variety.

A series of specimens of the Cauto cotton plant have been forwarded from Jamaica to Kew, and have been reported on (*Kew Bulletin*, 1914, No. 5, p. 198) as follows: "The specimens agree in most of their technical characters with *Gossypium brasiliense*, Macf., from which they differ, however, in the seeds being free from one another. In view of the statement that Cauto cotton is wild or semi-wild in south-eastern Cuba, it may possibly represent the wild stock of *G. brasiliense*; and having regard to its close agreement with that species, apart from the free seeds, it has been provisionally named *Gossypium brasiliense* var. *apospermum*, Sprague (var. nov.), as it seems desirable to have a definite name for such an important economic plant. At the same time, the possibility of its being a hybrid of *G. brasiliense* with some other species cannot be entirely excluded. The study of its behaviour on cultivation may perhaps throw some light on this point."

Fiji.—An account of experiments carried out at the Lautoka Experimental Station during 1913-14 is given in the *Fiji Royal Gazette* of October 9, 1914. Two kinds of Sea Island seed were sown; one of these was obtained from Barbados in 1906, and has since been cultivated continuously in Fiji, whilst the other was derived from St. Kitts. Good results were obtained, the yield of lint ranging from 252 lb. to 311 lb. per acre. Both kinds of seed furnished Sea Island cotton of a medium staple, and it is considered that such a product would be more generally useful and more readily saleable than the finer staples, as well as being obtainable in larger yields.

United States of America.—In a paper by Thos. H. Kearney, of the Bureau of Plant Industry, U.S. Dept. Agric., on "Mutation in Egyptian Cotton" (*Journ. Agric. Research*, 1914, **2**, 287), evidence is adduced to show that each of the principal Egyptian varieties originated in a mutant, i.e. an individual plant which showed an abrupt and definite change in the characters expressed. Certain new Egyptian varieties, established in Arizona during recent years, were produced in the same way. Two of these, the Yuma and Somerton varieties, have already been referred to in this BULLETIN (1911, **9**, 411), and two further varieties termed "Pima" and "Gila" are now described. The Yuma form is now grown on a commercial scale in the Salt River Valley, Arizona, but the Somerton variety has been abandoned because, although it produced excellent fibre, it was late in maturing, and developed vegetative branches to an excessive extent. The Pima variety appeared in 1910 as a single plant of marked individuality in a field of Yuma cotton; it yields fibre $1\frac{5}{8}$-$1\frac{3}{4}$ in. long, and of a pale buff colour with a tinge of pink. The Gila variety was discovered similarly in a field of acclimatised Mitafifi; it bears fibres about $1\frac{7}{16}$ in. long, and of a somewhat darker colour than that of the Yuma and Pima varieties.

TOBACCO

Bulletin No. 79, *U.S. Dept. Agric.*, entitled "Research Studies on the Curing of Leaf Tobacco," records experiments designed to compare the chemical changes which take place during the different methods of curing. The results show that in the curing of leaves which have been picked from the stalk the chemical changes are almost wholly due to respiration, while in curing leaves on the stalk the transference of amino compounds from the leaf to the stalk plays an important rôle. The picked leaves after curing contain larger quantities of amino compounds, mineral matter, and nitrate than the leaves cured on the stalk. In both cases, however, curing causes a large decrease in protein, often amounting to 60 per cent. of the amount originally present. It has been shown that in the case of cigar wrapper leaf types the average loss in weight of dry matter in the curing of picked leaves is 12 to 15 per cent., while in curing leaves on the stalk the loss is twice as great. In the curing of export and manufacturing types and of cigar filler types, which are harvested in a more mature condition, the loss in weight of dry matter is greater than in the case of cigar wrapper leaf, frequently amounting to 35 to 40 per cent., even when leaves are picked from the stalk. In the case of export types, where the stalks are usually split in harvesting, the loss in dry matter is considerably less than when the stalk is simply severed at the base.

FORESTRY AND FOREST PRODUCTS

Eucalyptus planting in Nyasaland.—The satisfactory growth of the Eucalyptus plantations at Zomba is referred to by the Chief Forest Officer in his report which appears in the *Ann. Rep. Dept. Agric., Nyasaland*, 1913–14. Limited quantities of poles and firewood are now being supplied to the Public Works Dept. from the oldest plantation, which was started about six years ago. This plantation is yielding at the rate of 2,455 cubic feet of solid wood fuel (= 3,437 cubic feet of stacked fire-wood) per acre, which is a higher yield than can be obtained from any other tree, either exotic or indigenous, in Nyasaland. In view of the fact that there is now little tree-growth in the more densely populated parts of the country, the Forestry division is endeavouring to induce the natives of those parts to plant up small areas of quick-growing trees in the neighbourhood of villages for the production of poles for hut-building and fuel for domestic use. A large number of seedling Eucalyptus trees have been issued free to natives for this purpose.

Experiments have also been conducted with a view to ascertaining the most suitable soil on which Eucalypts may be expected to give the most satisfactory crop of poles and firewood at an early age under ordinary conditions. So far, the best growths have been obtained on deep, chocolate-coloured, clayey loam and on drained swamp land. On poor, thin soil and dry, stony ridges, Eucalypts have proved more or less a failure. Good results have been obtained at Zomba, on land infested with termites, by planting Eucalyptus trees 4 × 4 or 4 × 3 ft. apart instead of 8 × 8 ft., which is the usual distance, as this allows for thinning by the termites. For the production of poles and fuel at an early age the following species have been found to give the best results:—*Eucalyptus tereticornis*, *E. rostrata*, *E. saligna*, *E. dealbata*, *E. rudis*, *E. Maideni*, and *E. citriodora*.

Mangrove Forests in the Philippine Islands.—A survey of the mangrove swamps in the Philippine Islands has recently been undertaken by the local Bureau of Forestry, those areas which lie along the south coast of Mindanao and at the head of Manila Bay being specially studied (*Ann. Rep., Dir. For., Philippine Is.*, 1912–1913, p. 27). Both virgin and cultivated mangrove swamps are found in these islands. Areas of the former kind are situated in Sibuguey Bay on the south coast of Mindanao and are sufficiently extensive to supply bark for one or more large mangrove cutch factories, but owing to the difficulty of disposing of the stripped trees as firewood, the exploitation of the virgin swamps in this district is at present impracticable.

Cultivated swamps exist in the upper part of Manila Bay and stretch from Malabon in the east to Balanga in the west, often for more than ten miles inland. Nipa palms (*Nipa fruticans*) and bacauan (*Rhizophora* sp.) are extensively planted in these parts, the latter being grown for firewood and sold principally in Manila. The supply is inadequate, so that every available portion of the swamps is utilised. The land chosen for planting bacauan is brackish or salt swamp near the edge of the rivers, where it will be affected by the tides, very soft mud being the most suitable soil for rapid growth. Planting takes place usually from May to August. The seedlings for this purpose, after having been gathered from existing plantations, are allowed to wilt for a fortnight in a shady place. In this condition, they are simply pushed a short distance in the mud so as to stand erect. Cultivation consists principally in keeping the plantations free from vines, but is usually scarcely necessary. The rotation adopted for bacauan cultivation as firewood is from eight to eleven years.

Several species of mangrove trees yield wood of good durability which can be successfully employed as piles, and durability tests are now being carried on to determine whether bacauan wood can be recommended for this purpose.

Besides these swamps in Mindanao, whose area is computed at 130,000 hectares (502 sq. miles), others of importance are found in various other parts of the Philippines.

Timbers

Panama Timbers.—With the opening of the canal it is expected that the timber industry of Panama will experience considerable development, as hitherto the cost of handling and transport before final shipment has limited the industry. According to the Report for the year 1913 on the Trade of the Republic of Panama (*Dipl. and Cons. Rep.* No. 5,338, *Ann. Ser.* [Cd. 7048-155], 1914), the chief woods which now pass through the port of Panama are cocobolo, mahogany, espavé, and guayacan, which come from the Bayano River district and from the Darien region. A supply of cocobolo exists in the hinterland of Chuman, and further inland is a good quantity of mahogany which it is said could be cut and brought down to the coast without much difficulty. Mahogany also exists in the Province of Los Santos in the neighbourhood of Tonosi, but owing to the necessity of transporting it by rail across the Isthmus it is doubtful if it could at present be exploited with profit, but with the canal in operation it should be possible to load direct into steamers at Balboa. Facilities for sawing timber in Panama are at present lacking.

Gums and Resins

Copal.—The copal forests on the Kassewe Hills of Sierra Leone have been surveyed recently and a reserve has been constituted, as it was found that the trees have been severely overtapped and a large proportion of the standing stock consequently killed outright. The trees will probably be allowed a rest of five or six years in which to recover before being tapped again. Those portions of the reserve which have been clear felled and farmed will be replanted with copal trees. The reserved area, 5,767 acres in extent, should yield from 80 to 100 tons of copal per annum (*Ann. Rep. For. Dept., Sierra Leone*, 1913, p. 1).

According to the *Board of Trade Journal* (1914, **85**, 778), a company with a capital of £30,000 has been formed to carry on dredging operations for the recovery of kauri "gum," which exists in large quantities in many of the swamps in the Northern Peninsula, New Zealand. A gold dredger has been purchased and altered for "gum" dredging. Operations are expected to be started this year. The swamps, after having been dredged, will be drained, and are expected to make an excellent dairying country.

Gum Arabic.—Since the fall in prices at the end of 1912, the gum trade of the Anglo-Egyptian Sudan has pursued a quiet course (*Ann. Rep. Cent. Econ. Bd., Sudan*, 1913, p. 7). The exports for 1913 were considerably smaller than those for 1912, being in 1913 15,129 tons, valued at £380,816, against 19,615 tons in 1912, valued at £618,599. This decrease in output is ascribed to the previous overproduction and to the fact that the native collectors have been less active owing to the lower prices obtainable. Of the amount exported in 1913, 3,641 tons were sent to France, 2,983 tons to Germany, and 2,821 tons to the United Kingdom.

Experiments are being carried on by the Forest Department to discover whether the cultivation of gum trees, in combination with forest catch crops, can be made to pay, and to show to what extent the quality and quantity of gum can be influenced by cultivation. An area of 1,000 acres at Um Ruaba in the Kordofan Province has been sown with the seed of the "hashab" gum tree, together with sesame seed. The plantation can be said to be on the whole in very fair condition in spite of difficulties as to labour supply and bad rains. From these trials, it should be possible to ascertain the yield of gum per tree during various periods of growth, the age to which a tree will continue productive, the average yield per acre on different soils, the best methods of tapping, and the cost of cultivation and net profit per acre.

Tanning Materials

Mangrove Bark.—*A Note on the Mangrove Forests of British India*, by R. S. Pearson, F.L.S. (Calcutta: Superintendent, Government Printing, 1914), discusses the possibility of utilising Indian mangrove bark commercially. Up to the present this tanning material has not been exported from India to Europe on a commercial scale, although large quantities are annually imported into Calcutta from the Sunderbans, and on a smaller scale into Rangoon and Moulmein from the coastal forests of British Burma.

The most important mangroves found in British India are *Rhizophora mucronata*, Lamk., *R. conjugata*, Linn., *Ceriops Candolleana*, Arn., *C. Roxburghiana*, Arn., *Kandelia Rheedii*, W. and A., and *Bruguiera gymnorrhiza*, Lam., while the largest forests are situated on the Arakan and South Tenasserim coasts, the Sunderbans, Andaman Islands, and to a less extent on the Bassein coast of British Burma.

Information is furnished as to the cost of collection of the bark, the quantities available, suitable localities for factories, labour, and local conditions. The Arakan and South Tenasserim districts are considered the two most promising areas available for the collection of the bark and its manufacture into a tanning extract in British India. The author states that the possibilities of utilising these mangrove barks commercially for tanning extract are fair to good, according to the locality selected.

Wattle Bark.—According to the *Ann. Rep. Dept. Agric., Brit. East Africa*, 1912–13, p. 14, the conditions in the East Africa Protectorate are considered to be slightly more favourable for the cultivation of wattle than in Natal, the prices realised for the small quantities of bark already marketed being larger than those secured for Natal bark, and the yield per acre being as much as 6 tons, as compared with about 4½ in Natal. The Natal planters, however, have the advantage of lower freight charges. It is estimated that from 7,000 to 7,500 acres of land have been planted with wattle in the Protectorate, but that the area of the plantations ready for stripping does not exceed 300 acres; after the lapse of another two years the annual output of bark should amount to 7,500 tons. It is feared that some difficulty may be experienced in air-drying the bark in the Kikuyu and Limoru districts, owing to the higher humidity of the atmosphere in those parts. Experiments are being undertaken at the Kabete Experimental Farm in the artificial drying of wattle bark. When the output reaches 7,000 tons of bark per annum it is hoped that a factory for the manufacture of tanning extract for export will be erected in the East Africa Protectorate.

ECONOMIC MINERALS

Asbestos.—In an article on the asbestos resources of the Thetford area in Quebec (*Monthly Bulletin* No. 27, 1914, *Can. Min. Inst.*) W. J. Woolsey estimates that 600,000 tons of asbestos rock, carrying 12 per cent. of asbestos, was treated prior to 1898. From 1898 to the present time 9,000,000 tons of rock, carrying 6 per cent. of abestos, has been treated.

The deepest points yet attained in quarrying are about 200 ft., at which depth, in all cases, the asbestos-bearing rock has been proved to exist in undiminished quantity. Assuming an average depth of 180 ft., and taking into consideration the boundaries of the asbestos deposit as mapped, it is estimated that there should be no less than 180,000,000 tons of asbestos-bearing rock, or a supply, at the present rate of production, sufficient for ninety years.

The chief reasons given for the apparent decrease in the value of the asbestos-bearing rock are (1) the rock is less carefully selected than formerly; (2) there has been an increase in the number of fibre producers owing to the adoption of the mechanical method of treating the rock; (3) there is a narrowing of the veins as greater depth is attained.

In a discussion appended to this paper, J. A. Dresser, who prepared the map on which the above estimate is based, remarks that the "spottiness" of the asbestos deposits makes such calculations as those of Mr. Woolsey extremely hazardous. The map on which the calculation is based is merely a preliminary one. Detailed larger scale maps are now being prepared by the Department of Mines at Ottawa to show the features of certain small but important parts of the serpentine belt; and these will afford a safer basis for making an estimate of the resources. Mr. Dresser is content for the present with the knowledge that the known reserves of the principal mines are large, and that further prospecting is likely to increase them greatly.

Coal.—In a publication issued by the Canadian Commission of Conservation (Toronto: The Bryant Press, Ltd., 1914), W. J. Dick, the mining engineer of the Commission, deals with the conservation of coal in Canada. He points out the desirability of appointing an engineering authority to guard against wasteful methods in mining. In some instances where there are several seams close together, the lowest is worked first, with the result that caving in occurs, and the mining of the upper seams is rendered impracticable. Much coal has been lost through carelessness in development, and it is claimed that in such instances the opinion of an engineering authority would have been useful in preventing loss.

At some mines, there is a considerable waste of slack

coal. An investigation of mines in Saskatchewan, Alberta, and British Columbia showed that the waste of unmarketable slack coal was from 10 to 35 per cent. of the output. This waste slack is dumped on the ground in some places; whilst on Vancouver Island, some of the producing mines dump as much as 10 to 15 per cent. of their output into the sea as waste slack.

The question as to the possibility of using low-grade coals, and preventing the waste of slack coal, is one of importance from the conservation point of view; and it is suggested that investigations should be carried on by the Government to determine the suitability of these materials for use as gas-producer fuel, and for the manufacture of briquettes for domestic use.

Many other aspects of the problem of conservation in coal mining are considered, and a detailed account is given of the work carried on in the coal mines of Nova Scotia, Saskatchewan, Alberta, and British Columbia.

Osmiridium.—In *Bulletin* No. 17, 1914, *Geol. Surv. of Tasmania*, W. H. Twelvetrees gives an account of the Bald Hill osmiridium field. Bald Hill is in the Heazlewood district in the north-western portion of the island. Geologically, Bald Hill forms part of a mass of serpentinised rocks that lies on the east of the granite of the Meredith Range. On the western side of the hill these serpentinised rocks are in contact with slates of the Dundas Series, of pre-Silurian age, but there is no evidence of metamorphism in the latter.

The osmiridium is obtained from the sands of the Savage river and those of the Nineteen Mile Creek and its tributaries. The mineral for the most part lies on the bottom, though a good deal is obtained by washing superficial material. The creek floors consist of "cement" which is hard enough to require blasting.

The general way of winning the material is to dig up the floor of the creeks with picks, or blast it, the material thus obtained being put into riffled sluice boxes. The material of the creek floor has sometimes to be broken up to the depth of a foot or more in order to get the osmiridium, which has settled into the crevices of the rock. The grains obtained are mostly small; the largest hitherto obtained weighs 9 dwt.

Osmiridium has also been obtained from the solid serpentine by crushing the rock and concentrating. This fact of the proved occurrence of osmiridium in the serpentine rock is of considerable interest, as the Bald Hill occurrence is the only one that has been definitely proved outside Russia, where osmiridium occurs in olivine rocks at Nijni Tagilsk.

A sample of Tasmanian osmiridium, examined at the Imperial Institute, consisted of loose metallic grains vary-

ing in colour from tin-white to yellowish-grey. Half the grains averaged about 1 mm. in diameter, and the other half about 0·5 mm. The sample was found on analysis to have the following composition:

		Per cent.
Platinum	Pt	0·37
Ruthenium	Ru	8·19
Palladium	Pd	0·21
Gold	Au	0·04
Iron	Fe	0·30
Copper	Cu	trace
Iridium and Rhodium	Ir and Rh	33·80
Osmium (by difference)	Os	57·09

The output of Tasmanian osmiridium in 1911 was returned as 272¾ oz., and in 1912 as 778¾ oz. The quantity won is largely determined by the nature of the season, as the "wash" in the Savage river can only be worked when the water is low.

Ozokerite.—According to the *Engineering and Mining Journal* (1914, **98**, 733), deposits of ozokerite or mineral wax occurring near Soldier's Summit and Colton in Wasatch and Utah counties, U.S.A., have recently been examined by Messrs. Day and Robinson, of the U.S. Geological Survey. The ozokerite occurs in veins that have a north and south trend, traversing sandstone and shale. These veins are fracture zones, varying from a few inches up to 12 ft. in thickness, and are impregnated with ozokerite. Some of the deposits carry as much as 3 per cent. of ozokerite. Occasionally there are found lenses of the pure mineral, from 1 to 2 ft. in thickness and 5 or 6 ft. long, and masses weighing as much as 175 lb. have been obtained. At the time of writing the price of ozokerite was 40 cents per lb., and the advance in price may make it possible to work these Utah deposits. Hitherto supplies of ozokerite have been obtained chiefly from Galicia, where it occurs in veins traversing Miocene sands and clays.

Petroleum.—In the *Monthly Bulletin* No. 27, 1914, *Can. Min. Inst.*, R. W. Brock gives some information relating to the strike of oil in the Dingman Well, near Black Diamond, in the Calgary District, Alberta. In this well oil was struck at a depth of 2,700 ft., and quickly rose to a height of from 2,000 to 2,200 ft. in the well. The oil is a "white oil," consisting of almost pure gasoline, and can be used in its crude state as a satisfactory motor spirit.

The well is situated on the apex of a saddle-like fold which is a mile or so in width, has a north-westerly trend, and dips steeply on both limbs.

The structure is thus favourable, but though a well of such oil is more profitable as a producer than a well of similar capacity of ordinary crude petroleum would be, it

is not so promising an indication. Experience in other fields has shown that these "white oils" are usually rather limited in quantity. Though, therefore, the strike of oil at the Dingman well is very encouraging, it cannot be regarded as demonstrating the existence of a commercially important field.

Pitchblende.—In *Professional Paper* 90—A, 1914, *U.S. Geological Survey*, E. S. Bastin gives an account of the geology of the pitchblende (uraninite) deposits of Colorado, and also deals briefly with the occurrences of pitchblende in Cornwall, and in the Erzgebirge of Bohemia and Saxony.

Pitchblende occurs in two ways in the United States. It is found in granite pegmatites in North Carolina; and in intimate association with metallic sulphides in certain mineral veins at Quartz Hill, near Central City, Gilpin Co., Colorado. It is only the latter occurrence that is of any commercial importance.

The oldest rocks of the Quartz Hill district are metamorphosed pre-Cambrian sediments, the predominant type being a quartz-mica schist, in which are intruded granites of pre-Cambrian age. Intrusive in both the igneous and metamorphic rocks are stocks and dykes of monzonite and bostonite, of probably Tertiary age.

The mineral veins of the district cut both the pre-Cambrian and Tertiary intrusives. There are two types of veins, viz. (1) the *pyritic type*, in which pyrite and quartz are the chief minerals, and are associated with small amounts of chalcopyrite, tetrahedrite, enargite, fluorite, and rhodochrosite; and (2) the *lead-zinc type*, in which the minerals are galena, zinc-blende, pyrite, chalcopyrite, quartz, and calcite. The lead-zinc veins were formed after the pyrite veins; but it is believed that the two types were merely successive epochs in one great vein-forming period, and that the formation of these veins was genetically connected with the monzonite intrusions.

The pitchblende occurs in intimate association with pyrite and chalcopyrite, in such a way as to show that it was deposited contemporaneously with these minerals. Some specimens of pitchblende show veinlets containing zinc-blende, pyrite, and galena. It is therefore inferred that the pitchblende was deposited during the earlier or pyritic mineralisation; that subsequent to this fracturing took place, and the fractures were filled by sulphides of the later or lead-zinc mineralisation.

Unlike the European pitchblende, that of Quartz Hill is not associated with nickel and cobalt minerals.

NOTICES OF RECENT LITERATURE

THE OXFORD SURVEY OF THE BRITISH EMPIRE. Edited by A. J. Herbertson, M.A., Ph.D., and O. J. R. Howarth, M.A. 6 vols. Demy 8vo. Vol. I.: The British Isles and Mediterranean Possessions. Pp. xii + 596. Vol. II.: Asia. Pp. x + 505. Vol. III.: Africa. Pp. xvi + 547. Vol IV.: America. Pp. x + 511. Vol. V.: Australasia. Pp. xii + 584. Vol. VI.: General Survey. Pp. viii + 386. (Oxford: Clarendon Press, 1914). Price £3 10s. net; or, separately, 14s. net per volume.

In the preface to this series of volumes it is explained that the object is "to furnish a survey of the British Empire and its constituent parts in their geographical and allied aspects, together with their economic, administrative, and social conditions at the present time." To carry out this object the editors have utilised the services of a large number of experts. Thus in the first volume twenty chapters are devoted to the British Isles, the first seventeen dealing with Great Britain and Ireland, and the last three with the Scilly Isles, the Channel Islands, and the Isle of Man, each of the twenty being by a different contributor. The Mediterranean Possessions, Gibraltar, Malta, and Cyprus, are described in Chapters XXI. to XXIII. Each volume also contains a Gazetteer of Towns and a series of statistical tables for the territories dealt with in it. This plan is followed throughout the series, the principal territory in each continent being dealt with in a series of chapters on physical geography and geology, climate, vegetation, fauna, agriculture, economic conditions, population, government and finance, and similar subjects, and the less important territories having, as a rule, one chapter each devoted to them. No objection can be taken to such a plan, but it works out rather curiously in some ways: thus the Channel Islands have thirty pages devoted to them, whilst Nigeria, with a far greater area, population, and potential wealth, has only thirty-nine pages given to it.

From the point of view of readers of this BULLETIN volumes II. to V., dealing with the overseas parts of the Empire, are likely to be the most interesting. It is impossible to review the volumes in detail within reasonable limits, and in this notice observations will be confined to the chapters dealing with economic resources. India naturally bulks very largely in Vol. II., dealing with the British Possessions in Asia, and the various chapters on Indian subjects are contributed by well-known authorities, who have acquired their information at first hand. Geology is dealt with by Mr. Oldham, Climate by Dr. G. T. Walker, Forestry by Sir S. Eardley-Wilmot, Agriculture and Industrial and Economic Conditions by Mr. J. S. Cotton.

In Vol. III. Mr. A. D. Hall gives a short but very good account of agriculture in the Union of South Africa, which is supplemented usefully on the economic and statistical side in the next chapter on "Economic Conditions and Communications," by the late Sir Richard Solomon, which includes a good account of the mining industries. The "Physical Geography and Geology" of the area are dealt with in Chapter I. by Dr. Rogers, Assistant Director of the Geological Survey of the Union. Chapters IX. to XXII., which deal with the Crown Colonies and Protectorates in Africa, each chapter being by a different author and concerning a single administrative unit, vary a good deal in their contents and quality, but they are all interesting, and for the most part adequate in treatment and up to date in their information.

Of the sixteen chapters forming Vol. IV., dealing with the British Territories in America, nine are devoted to Canada, one to Newfoundland, one to Labrador (by Dr. Grenfell), three to the West Indies, including British Guiana, and one to the Falkland Islands (by Dr. W. S. Bruce). A chapter might very well have been devoted to the agricultural and mining industries of Canada. Though these subjects are fairly exhaustively covered in Prof. Mavor's three chapters of Economic Survey, more technical as distinct from broadly economic information would have been useful, especially as regards agriculture in Canada.

Mr. Aspinall describes the topography, population, and government of the West Indies, while Sir Daniel Morris contributes two chapters dealing with Geology, Climate, Vegetation, and Fauna, and with Economic Conditions respectively.

Vol. V. is devoted to Australasia, and begins with an excellent chapter by Sir George Reid, entitled "Introductory Survey and Government." "Communications" and "Economic Conditions and Industries" are the titles of two very interestingly written chapters by Mr. Gullett, London Correspondent of the *Sydney Daily Telegraph*. "Mining and Economic Geology," by Mr. Griffith Taylor, summarises very well existing knowledge of the mineral resources of the Commonwealth.

Chapter XI., by Prof. P. Marshall, deals with the topography, geology, climate, etc., of New Zealand, while the Economic Conditions and the Population and Government of the same Dominion are described by Sir Robert Stout and Mr. T. Logan Stout.

Chapter XVI., by Mr. Griffith Taylor, deals with the British Sector of Antarctica.

Vol. VI. is a General Survey of Imperial problems of administration, defence, education, acclimatisation, commerce, communications, migration, etc., and naturally at

the present time, when statesmen are so much concerned with questions of Imperial organisation, it forms the most interesting volume of the series, fascinating as the others are in their broad display of the vast resources of the Empire.

The Oxford Survey of the British Empire is a production on which the publishers, the contributors, and, most of all, the editors can be heartily congratulated. The articles are all well written, interesting, and informative, and the maps and illustrations are abundant and good. The Clarendon Press has published many good books, but certainly none which excels this in interest to citizens of the British Empire.

THE POCKET GUIDE TO THE WEST INDIES, BRITISH GUIANA, BRITISH HONDURAS, THE BERMUDAS, THE SPANISH MAIN, AND THE PANAMA CANAL. By Algernon E. Aspinall. New and Revised Edition. Pp. viii + 488, Fcap. 8vo. (London: Duckworth & Co., 1914.) Price 5*s.* net; post free, United Kingdom 5*s.* 4*d.*, abroad 5*s.* 6*d.*

Since its publication in 1907 this "Guide" has been the indispensable *vade mecum* of all travellers and tourists in the West Indies. The general plan of the volume has been referred to in previous reviews in this BULLETIN. In the present edition the book has been rewritten to a considerable extent, and the scope of its usefulness enlarged by the inclusion of several admirable articles, notably those dealing with the Bermudas, the Bahamas, and British Honduras; whilst the section on the Panama Canal has been extended to include Colon and Panama.

Practical experience of the "Pocket Guide" shows it to be an almost ideal guide-book, lacking but two requirements—viz. a reasonably large map of the Caribbean, printed on strong paper and opening clear from the book; and a thin-paper edition.

ON THE TRAIL OF THE OPIUM POPPY. By Sir Alexander Hosie, M.A., LL.D., F.R.G.S. 2 vols. Vol. I., pp. viii + 300. Vol. II., pp. 308. Demy 8vo, photographs, 2 coloured maps and index. (London: George Philip & Son, Ltd.; Liverpool: Philip, Son, & Nephew, Ltd. 1914.) Price 25*s.* net; post free, United Kingdom 25*s.* 6*d.*, abroad 26*s.* 6*d.*

A straightforward and minutely detailed narrative of journeys made during 1910 and 1911 by the author (the well-known late British Consul-General at Tientsin) in the chief opium-producing provinces of China. The prime purpose of Sir A. Hosie's mission was to investigate the extent of poppy-cultivation in those north-western and western provinces, which had hitherto been the chief centre of its production. By an Imperial decree of September 20,

1906, the restriction of the cultivation of the poppy throughout China was ordered, and the term of ten years fixed for the complete prohibition of its use. The results of Sir A. Hosie's investigation as to how far in three and a half years the Chinese authorities had actually put their repressive work into force have already been made public in parliamentary papers, though they are briefly summarised again in the present volumes. The principal object of this book, however, is to point out the physical characteristics and economic conditions of those provinces—Shansi, Shensi, Kansu, Szechuan, Yünnan, and Kueichou—through which the author travelled, under Chinese official auspices, in a litter resembling a large sedan chair, but carried by mules instead of men, and consistently, we gather, uncomfortable.

Sir A. Hosie is an extremely careful observer. Nothing in his tedious transit seems to have escaped his curious eye, which neither heat nor cold nor make-shift accommodation at villainous inns with its attendant insect miseries could dim. He sees a lump of coal at one place in a yard, and promptly finds out whence the local supply is obtained and exactly what it costs; at another place he notes the small factories turning the bamboo forests into paper. His observation is, where necessary, backed up by a draft on his comprehensive knowledge of Chinese agriculture and plant life and of Chinese economic products generally. A meeting with a crop of the fibre-yielding plant *Abutilon Avicennae* in full bloom draws from him a most informing little dissertation on Chinese fibre-plants generally; the sight of a Catalpa tree reminds him of the use made of its wood by the Chinese in furniture. If at first—as in truth rarely happens—he is puzzled, the mystery does not long remain one. For a time he could not understand why each house in a certain hamlet had usually a patch of *Boehmeria nivea*, or China grass, attached to it. But the next hamlet a little farther on supplied the answer. "All its houses had on sale straw sandals, which are usually worn by wayfarers, and the fibre of China grass is used as cord for weaving and binding the straw together."

Amongst crops special attention was paid by Sir A. Hosie to the Chinese variety of lucerne (*Medicago sativa*), which he considers might be introduced with great advantage into Great Britain and the Dominions, inasmuch as it grows well up to an altitude of 4,000 ft.—"fears neither drought nor deluge, and once sown seems to require no further attention. It yields at least three crops a year, is eagerly devoured by cattle, and is reported to have excellent fattening qualities." The author procured a quantity of the seed of this lucerne, which was distributed by the Board of Agriculture in Great Britain, Canada, and South Africa. The results have been satisfactory, especially in South

Africa, whence a requisition for half a ton of seed was sent to China in 1912.

On the Trail of the Opium Poppy, which is fortunately well indexed, is, briefly, nothing less than a considerable contribution towards an encyclopædia of Chinese economic products. Its modest title covers a wealth of observation, of industry, and of knowledge.

THE PAN-ANGLES. By Sinclair Kennedy. Pp. ix + 244, Demy 8vo. (London: Longmans, Green & Co., 1914.) Price *7s. 6d.* net; post free, United Kingdom *7s. 10d.*, abroad *8s.*

This is a "consideration of the federation of the seven English-speaking nations"—the United Kingdom, Canada, Newfoundland, the Australian Commonwealth, New Zealand, the Union of South Africa, and the United States, written by an American. Mr. Kennedy points out that Benjamin Franklin, in 1754, initiated the thesis of these pages when he foresaw the need of a single Government based on the representation of both the American and British groups of self-governing English-speaking people. Mr. Chamberlain expressed it in general rhetorical terms when, speaking before a Canadian audience in 1897, he refused to make any distinction between the interests of Englishmen in England, in Canada, and in the United States. Mr. Kennedy holds that only by the union of all of these English-speaking nations can the integrity of any one of them be preserved in the face of the growing strength of China, of Russia, and of Japan. With Germany he thinks the seven English-speaking nations should form an alliance as a buffer against aggression in other quarters, but his book was apparently finished six months before the outbreak of the present war, and to be wise before the event is of course not easy.

Mr. Kennedy shows the urgent necessity for a real federation of governments (as distinct from a common but vague sentiment in this direction) between the United Kingdom and her nation colonies. If he has not added materially to the existing arguments for that step he has, by copious quotations, brought together in a most useful form the already expressed opinions of others. His plea that the United States should be included in this federation is eloquent, but by no means so convincing. The element of a common personal Sovereignty surely counts for much in the Imperial idea; its cementing influence—sentimental as it may be—is in the opinion of competent observers materially increasing. On what terms could the United States, which admits no such Sovereignty, enter a Pan-Angle Federation? By the way, if a word is to be coined to cover all the English-speaking races, surely even the slipshod English of, say, "Anglians" would be better than

the no English at all, not to say the hideousness, of "Pan-Angles."

WHY WE ARE AT WAR: GREAT BRITAIN'S CASE. By Members of the Oxford Faculty of Modern History. Pp. 206, Demy 8vo. (Oxford: At the Clarendon Press, 1914.) Price 2*s.*; post free, United Kingdom 2*s.* 4*d.*, abroad 2*s.* 5*d.*

THE WAR AND THE BRITISH DOMINIONS. By H. E. Egerton. Pp. 23, Crown 8vo. (Oxford University Press, 1914.) Price 2*d.*; post free, United Kingdom or abroad, 3*d.*

INDIA AND THE WAR. By Sir Ernest J. Trevelyan. Pp. 11, Crown 8vo. (Oxford University Press, 1914.) Price 1*d.*; post free, United Kingdom or abroad, 1½*d.*

One of the very few good features of the present war is the fact that it has made the British people realise the necessity of stating and explaining their instinctive attitude towards European politics.

The first of these Oxford University Press publications is from this point of view alone a most useful and opportune production, since it discusses without bias the causes which the British people are united in believing have given rise to this war and the principles which they think are in hazard. The scope of the book may be indicated sufficiently by quoting the heads of the six chapters into which it is divided. They are: The Neutrality of Belgium and Luxembourg; The Growth of Alliances and the Race of Armaments since 1871; The Development of Russian Policy; Chronological Sketch of the Crisis of 1914; Negotiators and Negotiations (a summary of the official negotiations which preceded the outbreak of war); The New German Theory of the State.

The series of four appendixes includes a reprint of the German White Book, as issued in English by the German Foreign Office.

The second and third publications form two of the series of "Oxford Pamphlets, 1914." The former describes why the British Dominions have rallied in unprecedented fashion to the support of the Mother Country in the present crisis. Sir E. J. Trevelyan's pamphlet discusses British policy in India, mentions some of the difficulties which the government of that country presents to its administrators, and finally describes the splendid and ungrudging support which the princes and peoples of India are now giving to this country.

THE COCONUT. By Edwin Bingham Copeland. Pp. xiv + 212, Demy 8vo. (London: Macmillan & Co., Ltd., 1914.) Price 10*s.* net; post free, United Kingdom 10*s.* 4*d.*, abroad 10*s.* 7*d.*

This book is written from a somewhat different standpoint from that of the already numerous works on the

coconut, being based on a series of lectures delivered by the author, who is Professor of Plant Physiology in the College of Agriculture of the University of the Philippines.

Climate and soil and the physiology of the plant are dealt with first; following this is a long chapter on diseases and pests; while the remainder of the book covers selection and treatment of seed, field culture, and coconut products. The chapter on diseases and pests is particularly good and contains useful information, both from the author's personal observation in the Philippine Islands and from the experience of investigators throughout the world; it forms, in fact, an excellent résumé of the present state of knowledge with regard to this important subject. It is interesting to note, in view of the frequent references to remedial measures for bud-rot, that the author agrees with other investigators in stating that remedial measures such as disinfection are useless and that destruction of infected trees by burning is the best means of preventing the spread of this disease.

The various aspects of coconut cultivation are well dealt with, but the concluding chapter on coconut products is somewhat disappointing. The native uses of coconut products and their manufacture are adequately dealt with, but the utilisation of copra for the manufacture of coconut oil and cake in Europe and elsewhere is dismissed in less than one page; even admitting that the work is intended primarily as a guide to those interested in the cultivation of the tree, it can hardly be contended that this is adequate treatment of the subject.

The book is eminently readable and well illustrated and will form a valuable addition to the libraries of all who are interested in coconut cultivation.

TIMBERS OF BRITISH GUIANA. By Herbert Stone and W. G. Freeman. Pp. xi + 110, Demy 8vo. (London: Published for the Government of British Guiana by the Crown Agents for the Colonies, 1914.) Price 5*s.* net; post free, United Kingdom 5*s.* 3*d.*, abroad 5*s.* 4*d.*

This book constitutes a report upon a collection of timbers made in British Guiana under the superintendence of the Hon. A. G. Bell, formerly Colonial Civil Engineer. The main objects of the report have been to obtain botanical identifications of the timbers, to collect information already published in regard to them, and to report upon their commercial utility and prospect of entering the English market. The first of these objects has been only partially successful on account of the notorious difficulty of obtaining complete botanical material, the leaves and fruits (only) available having been sufficient in some cases to determine

the species. It is interesting, however, to note that Purpleheart, one of the best known of Guiana timbers, is established as *Peltogyne paniculata*, Benth. In arrangement the book is on the useful lines rendered familiar in "Timbers of Commerce" by one of the authors, and it is evident that much labour and trouble have been expended in providing the detailed descriptions of the woods which will be of great value to timber specialists. Nevertheless, some disappointment is experienced on learning that "most of the specimens in this collection are from young, quickly-grown trees," though comparison with specimens from other sources convinced the authors they "might have expressed a higher opinion of these woods in almost every instance" had more mature samples been available. These facts probably explain the omission of any general summary of the results of this investigation. Nine clearly-printed photo-micrographs form a frontispiece.

THE MECHANICAL PROPERTIES OF WOOD. By S. J. Record. Pp. xi + 165, Med. 8vo. (New York: John Wiley & Sons. London: Chapman & Hall, Ltd., 1914.) Price *7s. 6d.* net; post free, United Kingdom *7s. 10d.*, abroad, *8s. 1d.*

The author, who is Assistant Professor of Forest Products in Yale University, deals in a very able manner with a subject which has received far less attention in this country than it deserves. Much work has been done on the timbers indigenous to certain British Colonies, *e.g.* New South Wales, and the author refers to the more important of these researches, but is in the main indebted to the work of the United States Forest Products Laboratory, Wisconsin, for details of the methods of timber testing and their interpretation. The book is divided conveniently into three parts; Part I. deals with the fundamental properties of woods, such as strength in bending, compression, etc., hardness, and other properties. Part II. discusses the factors affecting the mechanical properties of wood. In this section important questions such as the influence of rate of growth, presence of faults, fungoid attack, and treatment with preservatives, on the quality of wood are discussed. In Part III. the methods of testing woods are described. This section is particularly clear and well arranged; possibly the author might find it advantageous to add in future editions a short discussion of the relative merits of the different types of testing machines which have been employed up to the present for timber testing. A particularly valuable feature is the full bibliography of works and articles dealing with the properties of timber, timber testing, etc.; this is probably the most complete list published up to the present time, and is of great interest and value.

A TEXT-BOOK OF GRASSES: With especial reference to the economic species of the United States. By H. S. Hitchcock. Pp. xvii + 276, Crown 8vo. (New York: The Macmillan Company, 1914.) Price 6*s.* 6*d.* net; post free, United Kingdom 6*s.* 10*d.*, abroad 7*s.* 1*d.*

This book, written by the Systematic Agrostologist to the United States Department of Agriculture, is intended primarily as a text-book for students of systematic agrostology. The first part deals briefly with the economic uses of grasses, including an account of forage plants, pasture and meadow plants, hay, lawn, soil- and sand-binding grasses, weeds, etc. Part II., which occupies the bulk of the book, deals with the morphology of the vegetative and floral organs of grasses, their ecology, and chiefly with classification. Keys for the determination of all the genera found growing wild or in common cultivation in the United States are given, as well as more complete descriptions of the most important genera and species. The nomenclature followed is that of the American code, but synonyms are introduced whenever a species or genus has been commonly known under another name.

A useful list is given of recent publications on the economic uses of grasses issued by the United States Department of Agriculture, and another of books and articles chiefly dealing with the classification of North American grasses.

The book should prove of considerable value to agricultural students in the United States.

DIE WICHTIGSTEN KRANKHEITEN UND SCHÄDLINGE DER TROPISCHEN KULTURPFLANZEN UND IHRE BEKÄMPFUNG. By Dr. Friedrich Zacher. 1 Band. Pp. viii + 152, Demy 8vo. (Hamburg: Fr. W. Thaden, 1914.) Price 4 marks; post free, United Kingdom 4*s.* 3*d.*; abroad 4*s.* 4*d.*

This little book is the first volume of a work intended to serve as a practical handbook of tropical plant pests and diseases for the use of agriculturists in the German colonies. The magnitude of the task appears to have been no deterrent to the author, who deals with his subject confidently under the familiar headings of "symptoms," "distribution," "life-history," and "treatment," to which is added, in the case of fungoid diseases, the optimistic "prevention and cure."

The first part, which deals with the general principles of plant sanitation, is an informing introduction to the subject, which would be welcomed by many planters; while the second part, comprising the main part of the book, deals with the characteristic diseases of cotton, cocoa, coffee, and tea, though the last-mentioned crop can

scarcely be regarded as an important culture in any German colony. The section appears to have been carefully compiled, though no claim can be made to completeness. The author takes up a cautious attitude in regard to the important canker of cocoa, and insufficient weight appears to have been given to the important work of Rorer in Trinidad and Petch in Ceylon; indeed, no reference is made to the Ceylon investigations. The book is illustrated, many of the figures being familiar; others, which appear to be original, will have small practical value.

ORE DEPOSITS. By F. Beyschlag, J. H. L. Vogt, and P. Krusch. Translated by S. J. Truscott. Vol. I. Pp. xxviii + 514, Demy 8vo, with 291 illustrations. (London: Macmillan & Co., Ltd., 1914.) Price 18*s.* net; post free, United Kingdom 18*s.* 6*d.*, abroad 19*s.* 3*d.*

This is a translation from the German of the first of three volumes of a well-known and very useful work on economic mineral deposits. The cover of the book carries the familiar title of "Ore Deposits"; but as indicated on the title-page, it is the aim of the book to deal comprehensively with "the deposits of the useful minerals and rocks, their origin, form, and content."

The first half of the volume deals with the morphology, classification, and mineral content of ore deposits. Among other important subjects dealt with at considerable length in this part of the volume are the formation of minerals, and the distribution of the elements in rocks; whilst other smaller sections deal with "the absolute and the relative amounts of the metals in useful ore deposits," "primary and secondary depth zones," and "indications of ore deposits at the surface."

In the second half of the volume there is given an account of the scientific classification of ore deposits. The main subdivisions adopted by the authors are:

1. Magmatic segregations.
2. Contact deposits.
3. Cavity fillings and metasomatic deposits.
4. Ore beds.

Of these subdivisions, magmatic segregations and contact deposits are dealt with in detail in this volume, together with three of the nineteen types of cavity-filling and metasomatic deposits.

The volume is very well illustrated and indexed. English students will feel grateful to Prof. Truscott for having undertaken the careful translation of this useful and authoritative work.

THE MINING WORLD INDEX OF CURRENT LITERATURE. Vol. V., first half-year, 1914. By G. E. Sisley. Pp. xxix + 237, Med. 8vo. (Chicago: The Mining World Company 1914.) Price $2; post free, United Kingdom 8*s.* 8*d.*, abroad 8*s.* 11*d.*

This is an international bibliography of mining, compiled and revised semi-annually from the index of the world's current literature published weekly by the *Mining and Engineering World*. All branches of the subject are dealt with, and Vol. V., like its predecessors, is a very thoroughly compiled and useful bibliography.

PHILLIPS' PAPER TRADE DIRECTORY OF THE WORLD, 1913–14. Pp. lxxx + 914, Demy 8vo. (London: S. C. Phillips & Co., 1914.) Price 15*s.* 6*d.*; post free, United Kingdom 16*s.*, abroad 16*s.* 8*d.*

This useful work is a compendium of information on the world's paper trade. It contains lists of (1) paper mills, arranged under their respective countries; (2) the wood pulp mills, with an indication of the kind of pulp manufactured, whether mechanical or chemical, and in the latter case whether produced by the sulphite, sulphate, or soda process; (3) buyers of paper, boards, and stationery in all parts of the world; (4) millboard makers, enamellers, paper stainers, paper agents, exporters, paper stock merchants, wholesale stationers, and paper box and bag makers; and (5) registered water-marks of the various mills and stationery firms. Information is also given on the various paper-makers' associations and the paper trade customs of different countries, and a glossary of commercial and trade terms in six languages is provided.

The new issue of the directory has been brought up to date in all particulars, and will doubtless be of great value and utility to all engaged in paper-making and the various branches of the paper trade.

PRACTICAL TROPICAL SANITATION. By W. Alex. Muirhead. Pp. xiv + 288, 8vo. (London: John Murray, 1914.) Price 10*s.* 6*d.* net; post free, United Kingdom, 10*s.* 10*d.*, abroad 11*s.* 2*d.*

A knowledge of tropical hygiene is indispensable to those occupying Sanitary Inspectorships in tropical colonies, and the Colonial Office now requires a certificate of competency in the science from candidates for appointments of this kind on the West Coast of Africa. The present work is intended specially for the use of candidates for tropical sanitary appointments. In addition to the practical applications of hygiene, it deals briefly, but lucidly, with the fundamental principles of disease causation and prevention, and the preservation of health.

After a general account of the causes of disease, the chief tropical diseases are described and the preventive measures to be taken in each case dealt with. Special attention is devoted in the latter connection to disease-bearing mosquitoes and other flies. Subsequent chapters deal with disinfection; the composition of the atmosphere and the subject of ventilation; water and water supplies; food, including an account of the diseases of animals used for food; the collection, removal, and disposal of excreta and refuse; habitations; and a brief outline of sanitary law and a discussion of the practical application of hygienic principles. An appendix contains a number of useful notes, tables, and formulæ.

The book is very well printed and contains numerous illustrations. It should prove useful not only to Sanitary Inspectors, but to estate managers, mine owners, and others in the tropics concerned with the welfare of employees.

BOOKS RECEIVED

COCOA. By Dr. C. J. J. van Hall. Pp. xvi + 515. (London: Macmillan & Co., Ltd., 1914.) Price 14*s.* net; post free, United Kingdom 14*s.* 6*d.*, abroad 15*s.*

ELEMENTS OF FORESTRY. By F. F. Moon and N. C. Brown. Pp. xvii + 392. (New York: John Wiley & Sons; London: Chapman & Hall, 1914.) Price 8*s.* 6*d.* net; post free, United Kingdom 8*s.* 11*d.*, abroad 9*s.* 3*d.*

AN INTRODUCTION TO THE GEOLOGY OF NEW SOUTH WALES. By C. A. Süssmilch. 2nd. ed. Pp. xviii + 269. (Sydney: Angus & Robertson, Ltd.; London: The Oxford University Press, 1914.) Price 7*s.* 6*d.* net; post free, United Kingdom 7*s.* 10*d.*, abroad 8*s.* 2*d.*

THE GUIDE TO SOUTH AND EAST AFRICA. Edited by A. Samler Brown and G. Gordon Brown. 21st ed. Pp. liv + 694. (London: Sampson, Low, Marston & Co., Ltd., 1915.) Price 1*s.*; post free, United Kingdom 1*s.* 4*d.*, abroad 1*s.* 8*d.*

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PRINTED BY
HAZELL, WATSON AND VINEY, LD.,
LONDON AND AYLESBURY,
ENGLAND.